

IBTM5660 Utility Services

<http://ibse.hk/IBTM5660/>



Extra Low Voltage Systems

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- Basic concepts
- CABD and SMATV systems
- PBX and PA systems
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- Burglar & intruder alarms



Basic concepts

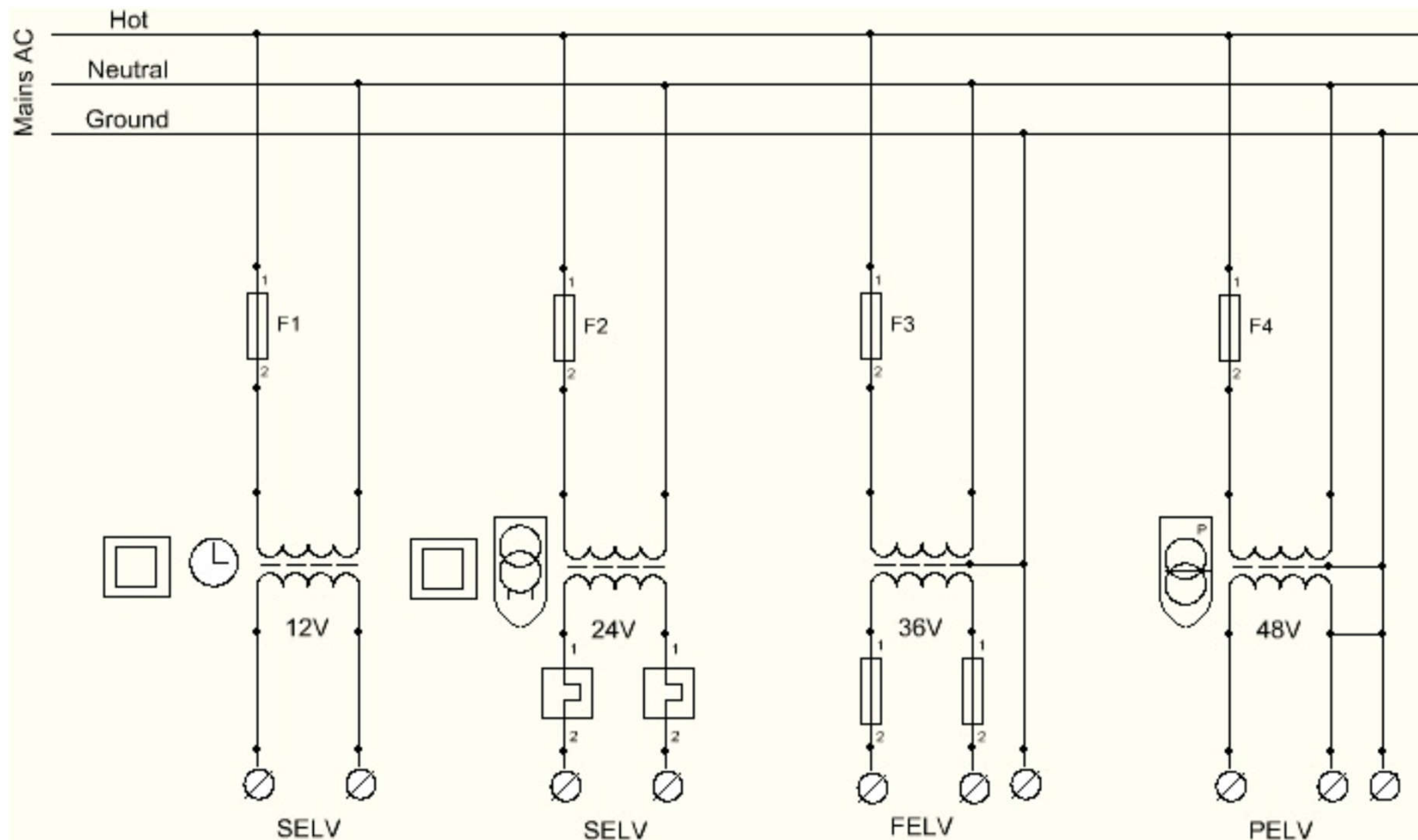
- Extra low voltage (ELV): (特低壓電 / 弱電)
 - < 50 volts AC or < 120 volts DC (BS 7671)
 - Low risk of dangerous electrical shock
 - Intrinsically safe circuits (BS 1259)
- Three types of ELV sources:
 - Safety extra low voltage (SELV)
 - Protective extra low voltage (PELV)
 - Functional extra low voltage (FELV)



Do you
know why
we need
ELV?

Electricity supply voltage & installations for extra low voltage

Voltage range	AC RMS voltage (V)	DC voltage (V)	Defining risk
High voltage	> 1000	> 1500	Electrical arcing
Low voltage	50 to 1000	120 to 1500	Electrical shock
Extra-low voltage	< 50	< 120	Low risk



FELV = Functional extra low voltage; PELV = Protective extra low voltage; SELV = Safety extra low voltage

(Source: Extra-low voltage - Wikipedia https://en.wikipedia.org/wiki/Extra-low_voltage)



Basic concepts

- Safety extra low voltage (SELV) must be
 - Safely separated from other circuits that carry higher voltages
 - Isolated from earth (ground) and from the protective earth conductors of other circuits
- The safety of an SELV circuit is provided by
 - The extra low voltage
 - Low risk of accidental contact with a higher voltage
 - Lack of a return path through earth (ground) that a current could take in case of contact with a human body



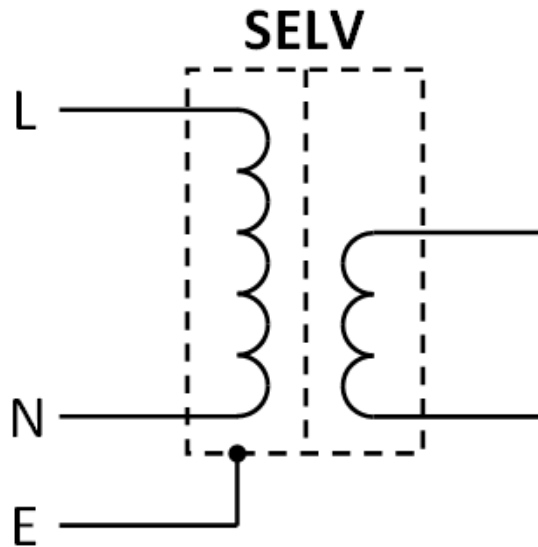
Basic concepts

- Protective extra low voltage (PELV)
 - Has a protective earth (ground) connection
 - Such as a computer with a IEC Class I power supply
- Functional extra low voltage (FELV)
 - Any other extra low voltage circuit that does not fulfill the requirements for an SELV or PELV circuit
 - Such as part of the circuit uses an ELV
 - Protection requirements for the higher voltage have to be applied to the entire circuit



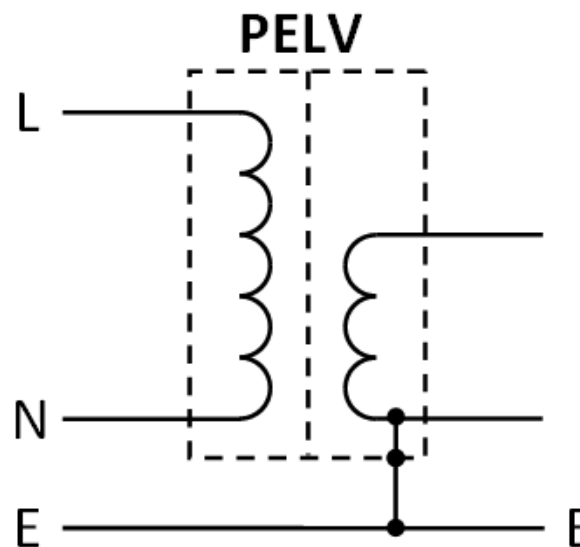
Video: Safety for extra low voltage circuit (5:18) <https://youtu.be/fdxE8bl8Kmo>

Three types of extra low-voltage (ELV) systems



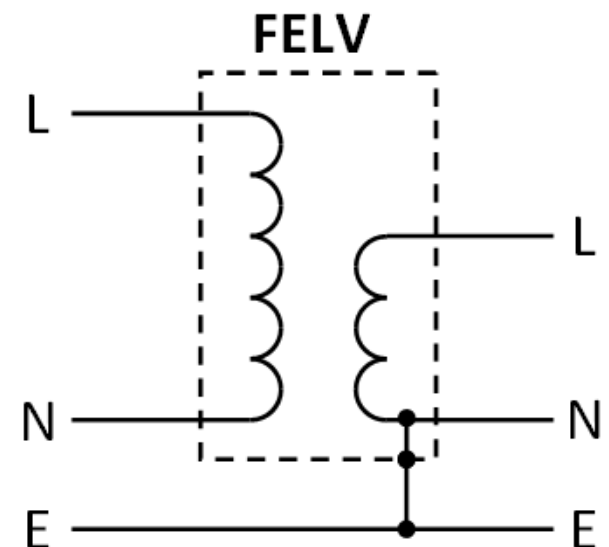
Safety extra low voltage (SELV)

- Presence of a special insulation
- The loads are not isolated by earthing (grounding)
- Eliminate the connection between earth & the equipment



Protective extra low voltage (PELV)

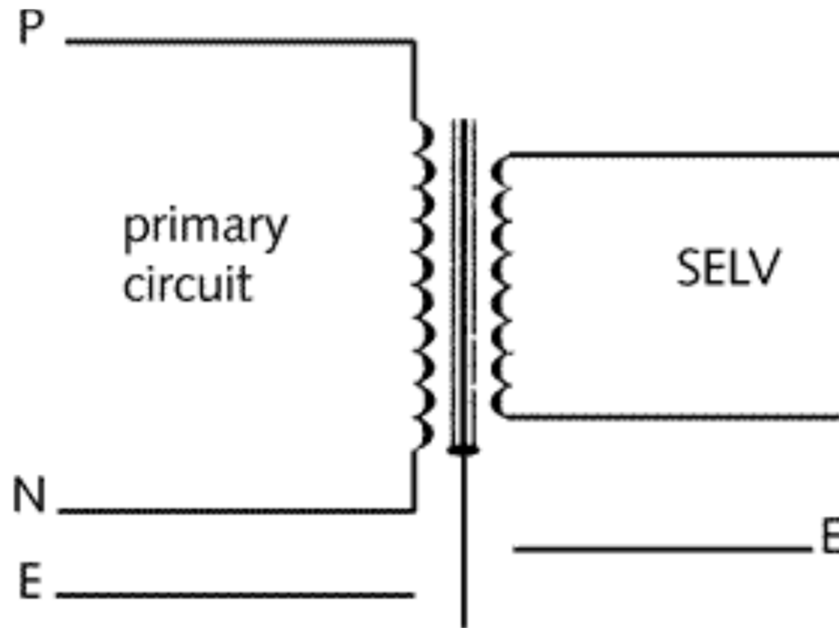
- Presence of a special insulation
- The loads are not isolated by earthing (grounding)



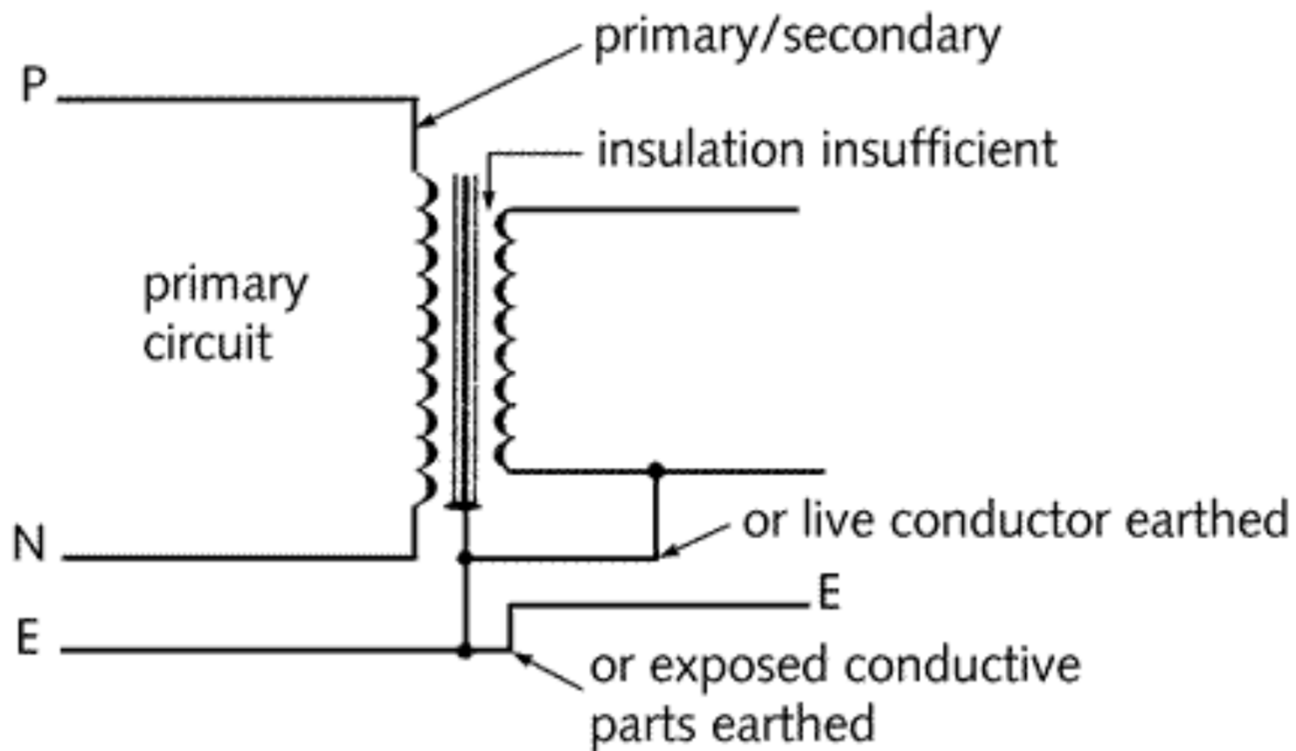
Functional extra low voltage (FELV)

- Special insulation is not required
- The loads are not isolated by earthing (grounding)

Earthing relationship, SELV and FELV systems



Safety extra low voltage (SELV)

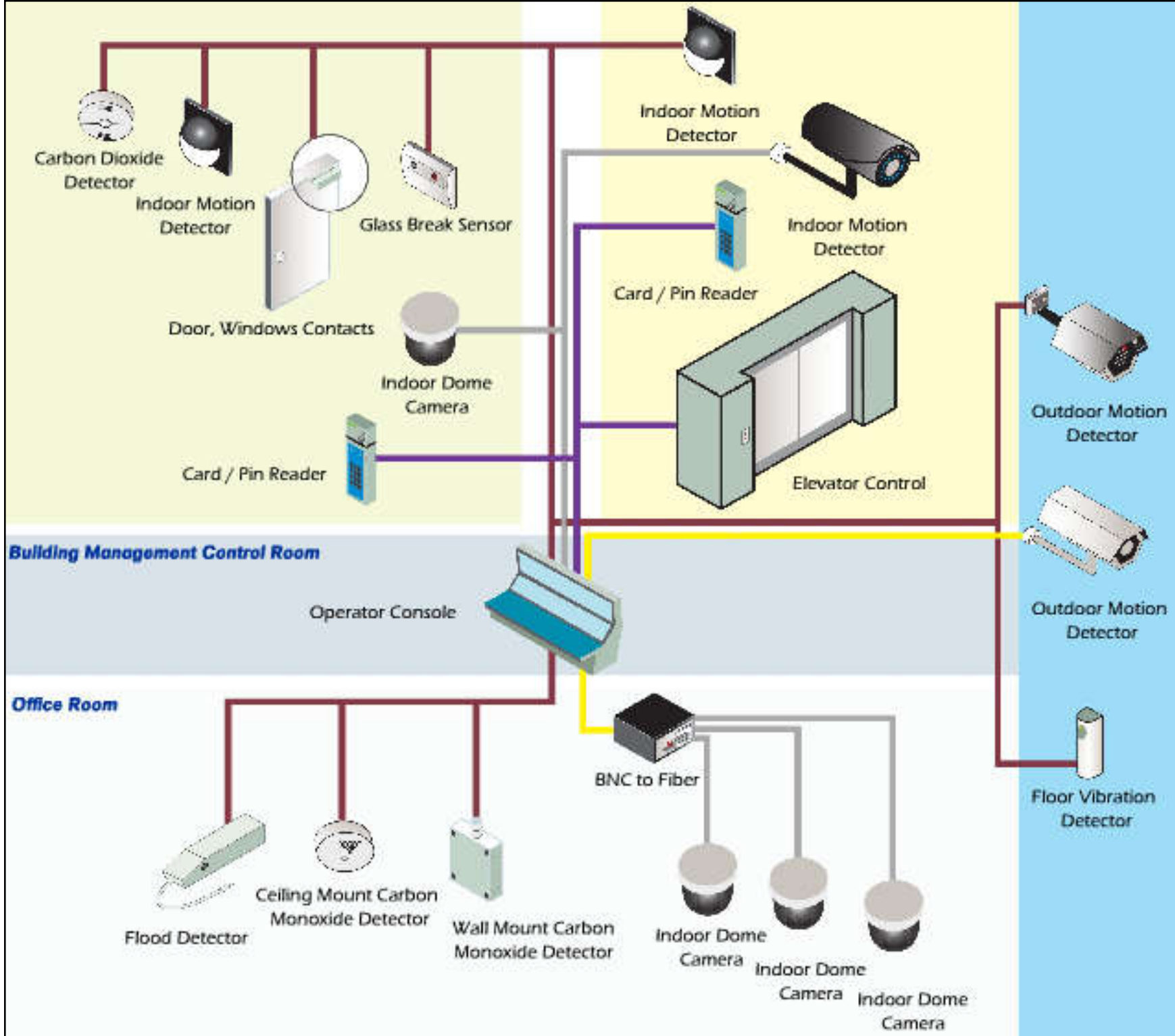


Functional extra low voltage (FELV)



Basic concepts

- Common ELV systems include:
 - Communal aerial broadcast distribution (**CABD**)
 - Also known as “Public TV antenna” (公共天線)
 - Satellite master antenna television (**SMATV**) 衛星電視共用天線
 - Private branch exchange (**PBX**) telephone systems
 - Public address (**PA**) systems
 - Computer networking systems
 - Audio/visual system & intercom systems
 - Fire alarms & security systems



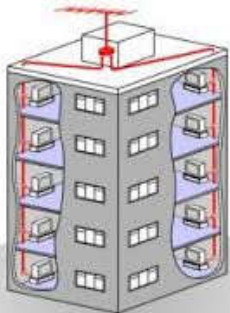
Examples of extra low voltage (ELV) systems & devices in buildings

CABD and SMATV systems

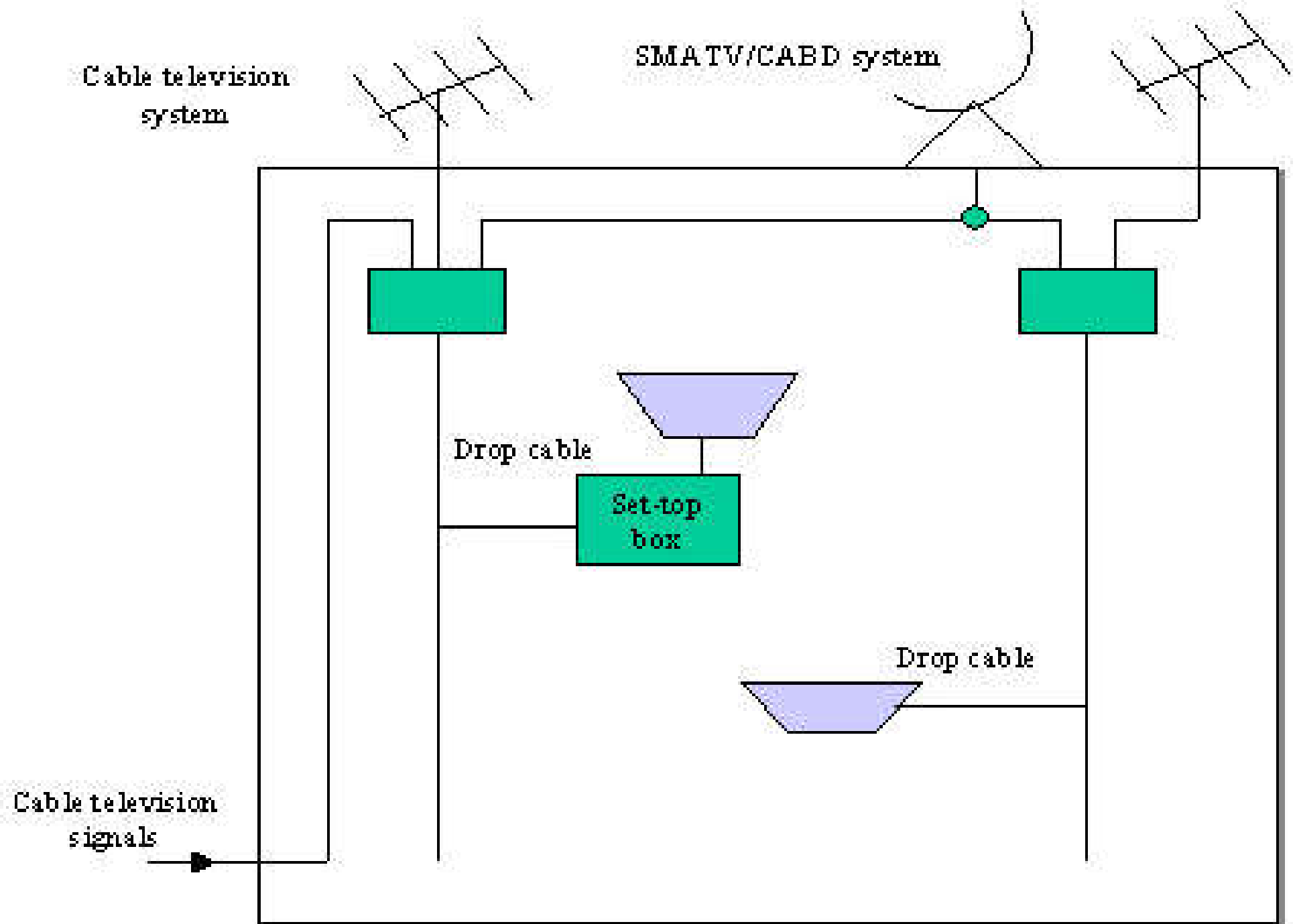


- CABD and SMATV systems

- Also known as “In-Building Coaxial Cable Distribution Systems” (IBCCDS)
 - Comprises aerial, head-end equipment (amplifier/filter) and co-axial cable network (block wiring systems) inside multi-storey buildings
 - For reception & distribution of TV & FM radio broadcast
 - In some buildings, it is also used to distribute cable TV, satellite TV, closed circuit television (CCTV) & Internet services



In-building coaxial cable distribution system (IBCCDS)



CABD and SMATV systems



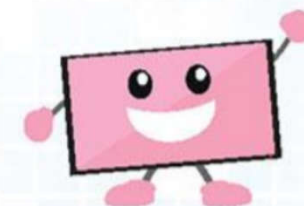
- CABD and SMATV systems (cont'd)
 - Services include:
 - Free TV Programme (TVB, HK Open TV & ViuTV)
 - Satellite TV
 - Pay TV (CableTV, PCCW Media & TVB Pay Vision)
 - Digital Terrestrial Television (DTT) (from 2007)
 - SMATV: receiver dishes on rooftops & signals are fed down through IBCCDS
 - Set-top boxes (機頂盒) : access function & security function

CABD and SMATV systems



- Digital TV

- Broadcast TV services in digital format
 - Clear picture & no ghosting
- Supports more free-to-air TV channels, high definition TV (HDTV) & interactive TV
- Support mobile / portable reception
- How to receive it?
 - External decoder added between TV socket and conventional TV set
 - Integrated digital TV set with decoder built in



Comparison of analogue & digital TVs



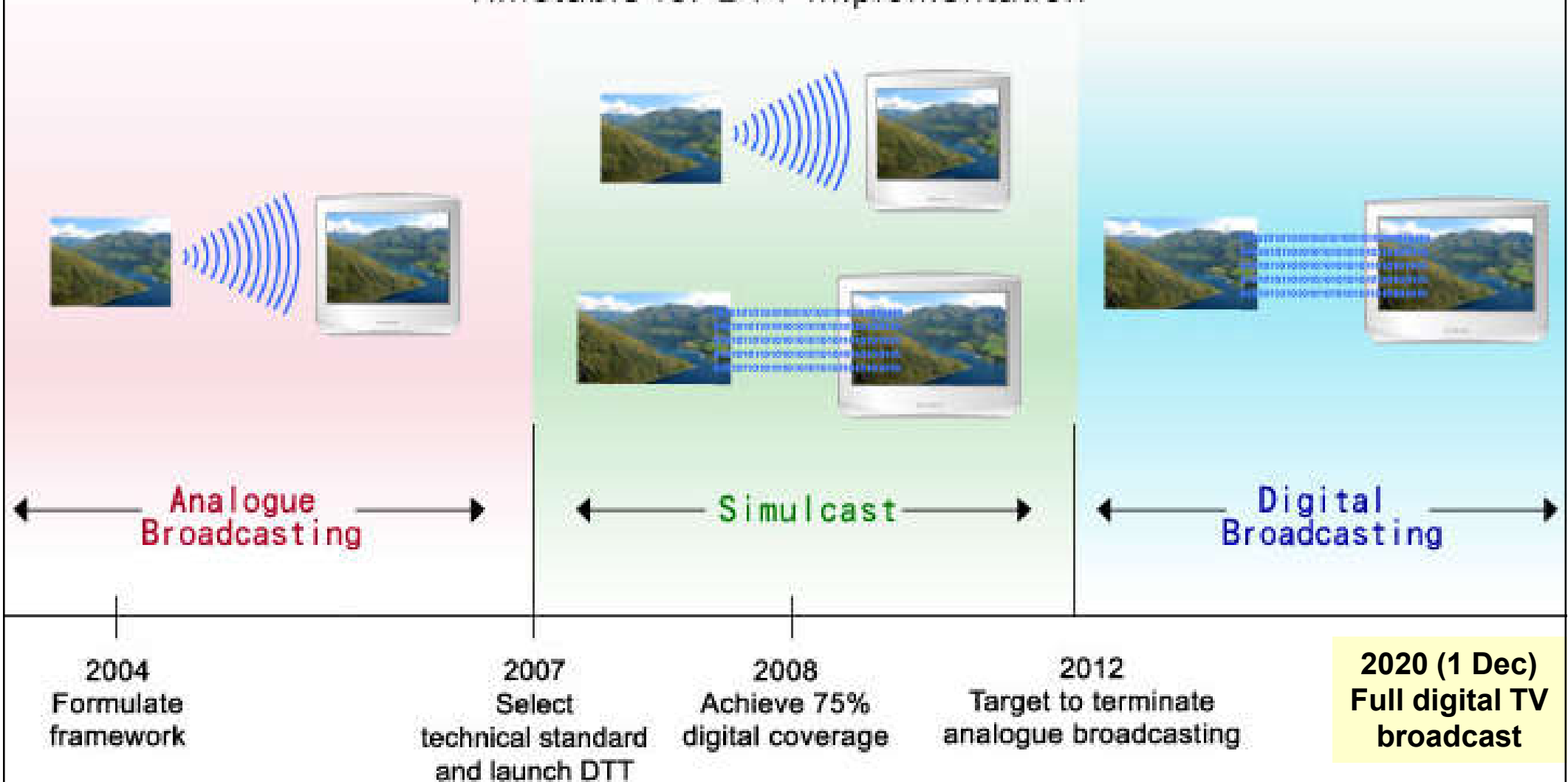
What type of TV do you have at home?



Analogue TV (standard definition)	Digital TV (high definition)
Resolution up to 575 lines (vertical) x 720 pixels (horizontal)	Resolution up to 1080 lines (vertical) x 1920 pixels (horizontal)
Aspect ratio 4:3	Aspect ratio 16:9 (Widescreen)
Stereo sound	Multi sound channels (e.g. Dolby 5.1 multi-channel sound)

Timetable for Digital Terrestrial Television (DTT) implementation in HK

Timetable for DTT Implementation



(* Simulcast = simultaneous analogue & digital broadcasts)

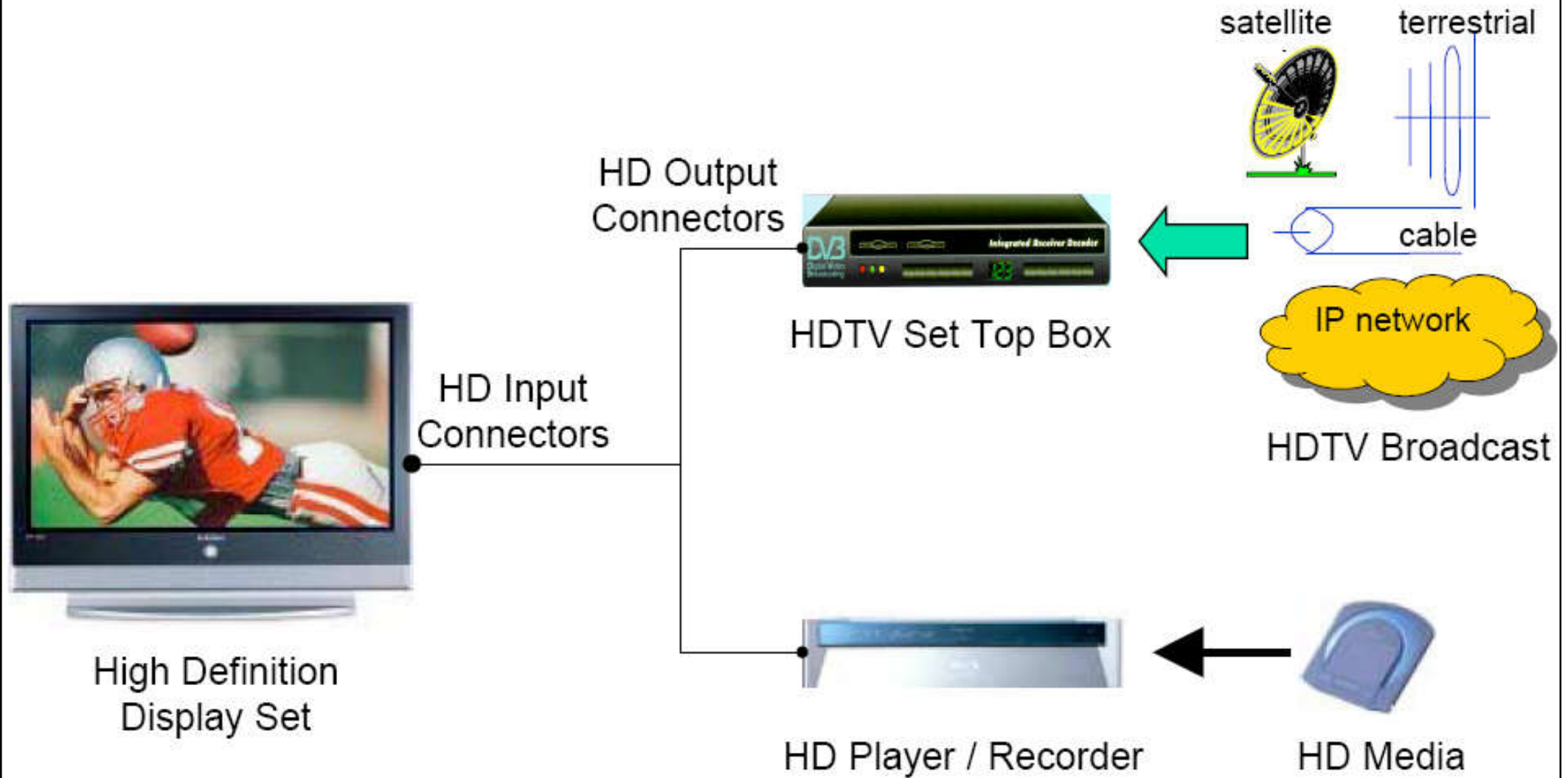
CABD and SMATV systems



Digital TV platforms in Hong Kong

- Terrestrial radiocommunications
 - Through Ultra High Frequency (UHF) radio spectrum
 - By TVB and ATV (launched in Dec 2007)
- Cable (e.g. by Cable TV)
 - Via hybrid fibre coaxial cable (HFC) network
- Broadband network
 - By PCCW Media & TVB Pay Vision (Galaxy)
- Satellite (through SMATV systems)
 - Some foreign & local satellite television broadcasts are providing HDTV programmes

High definition TV (HDTV) equipment setup



Transmitting stations of digital terrestrial television (DTT) in HK

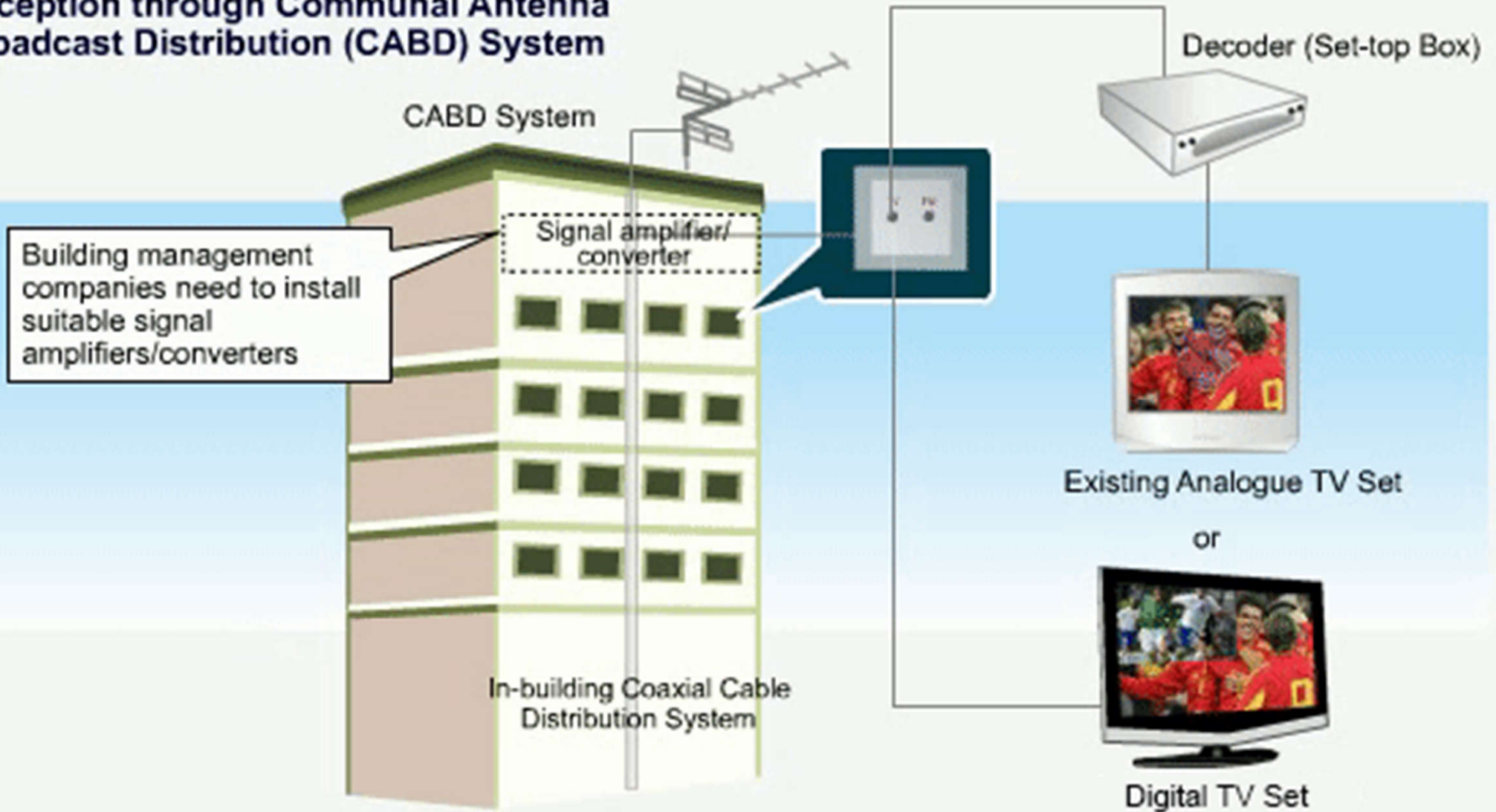


Remarks: Estimated locations of transmitting stations are shown for reference only

(Source: www.digitaltv.gov.hk)

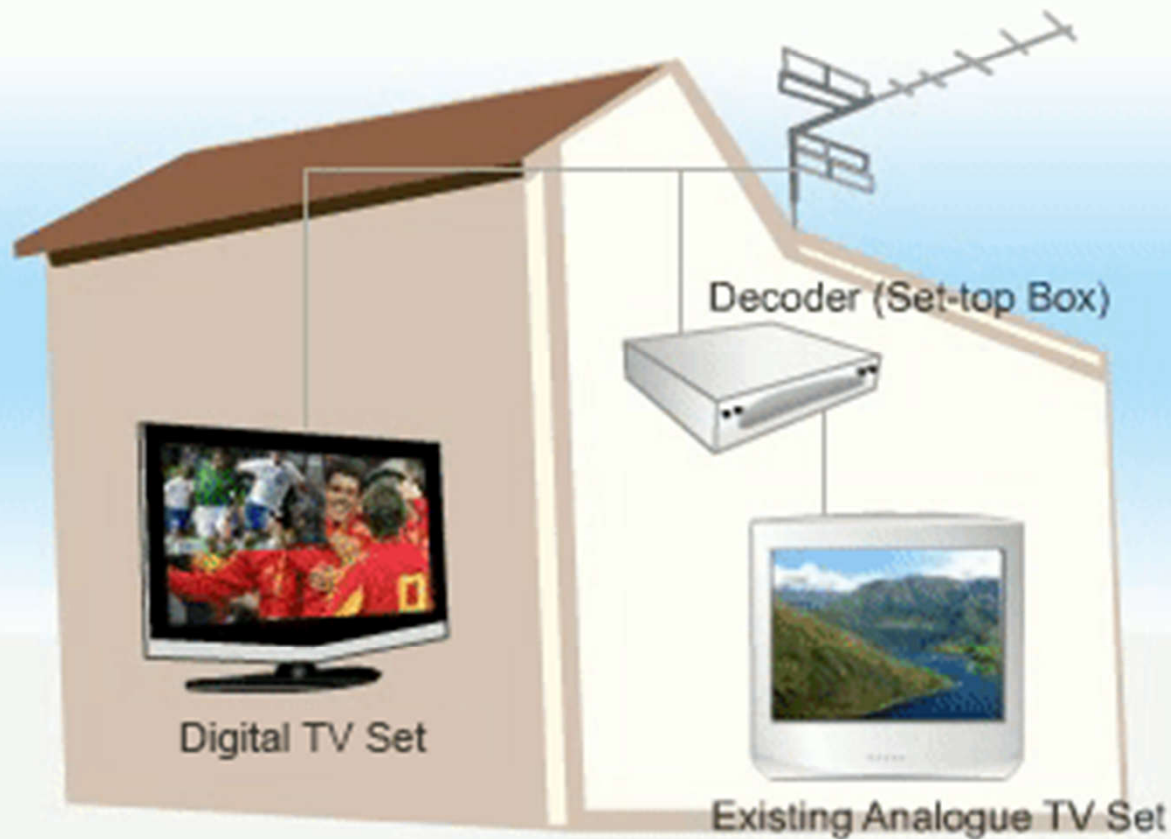
Reception of Digital TV signals through CABD systems

Reception through Communal Antenna Broadcast Distribution (CABD) System

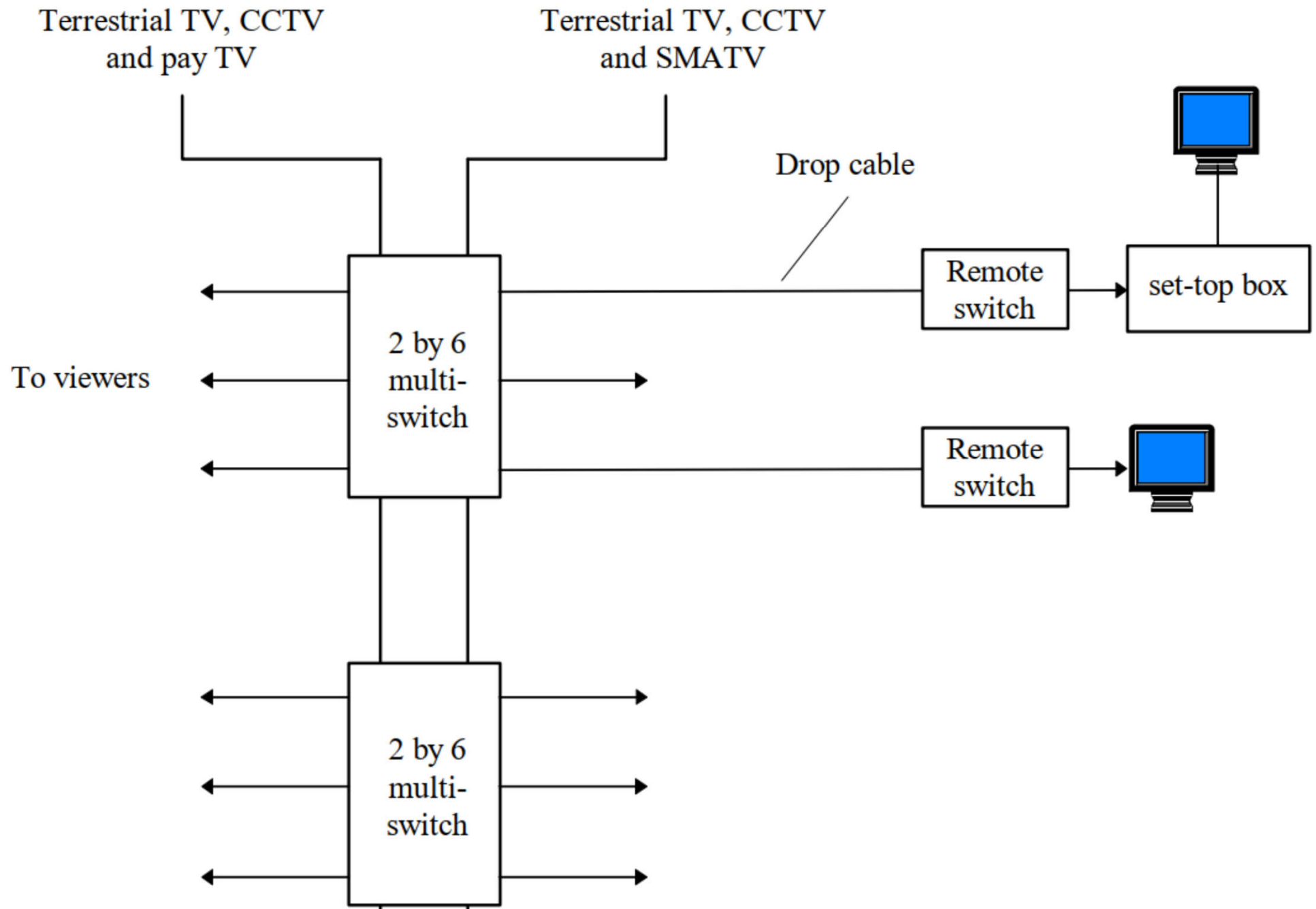


Reception of Digital TV signals through rooftop antenna

Reception through Rooftop Antenna

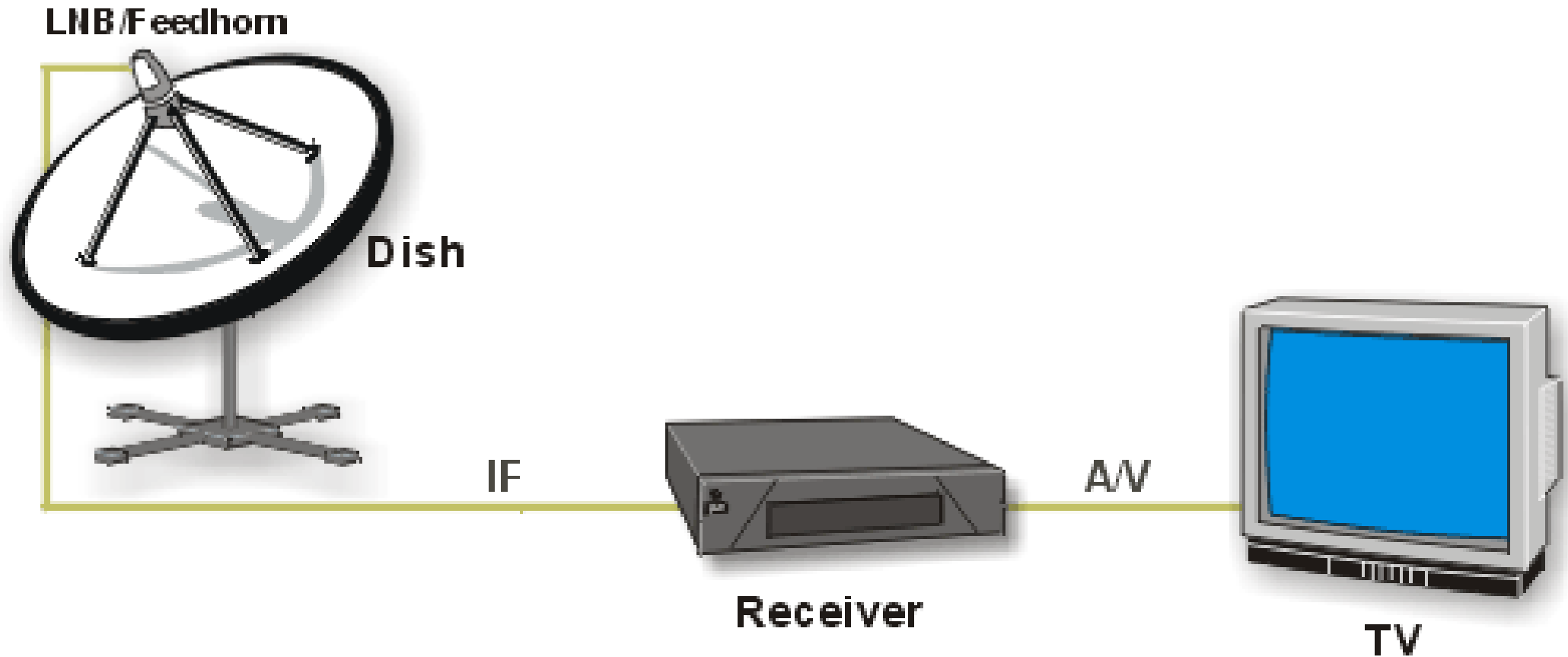


Typical configuration of a parallel distribution system



(Source: CA, 2012. *Code of Practice for the Installation and Maintenance of In-Building Telecommunications Systems and In-building Access by Telecommunications Network Operators*, Communications Authority (CA), Hong Kong. <https://www.coms-auth.hk/filemanager/statement/en/upload/105/cop201202e.pdf>)

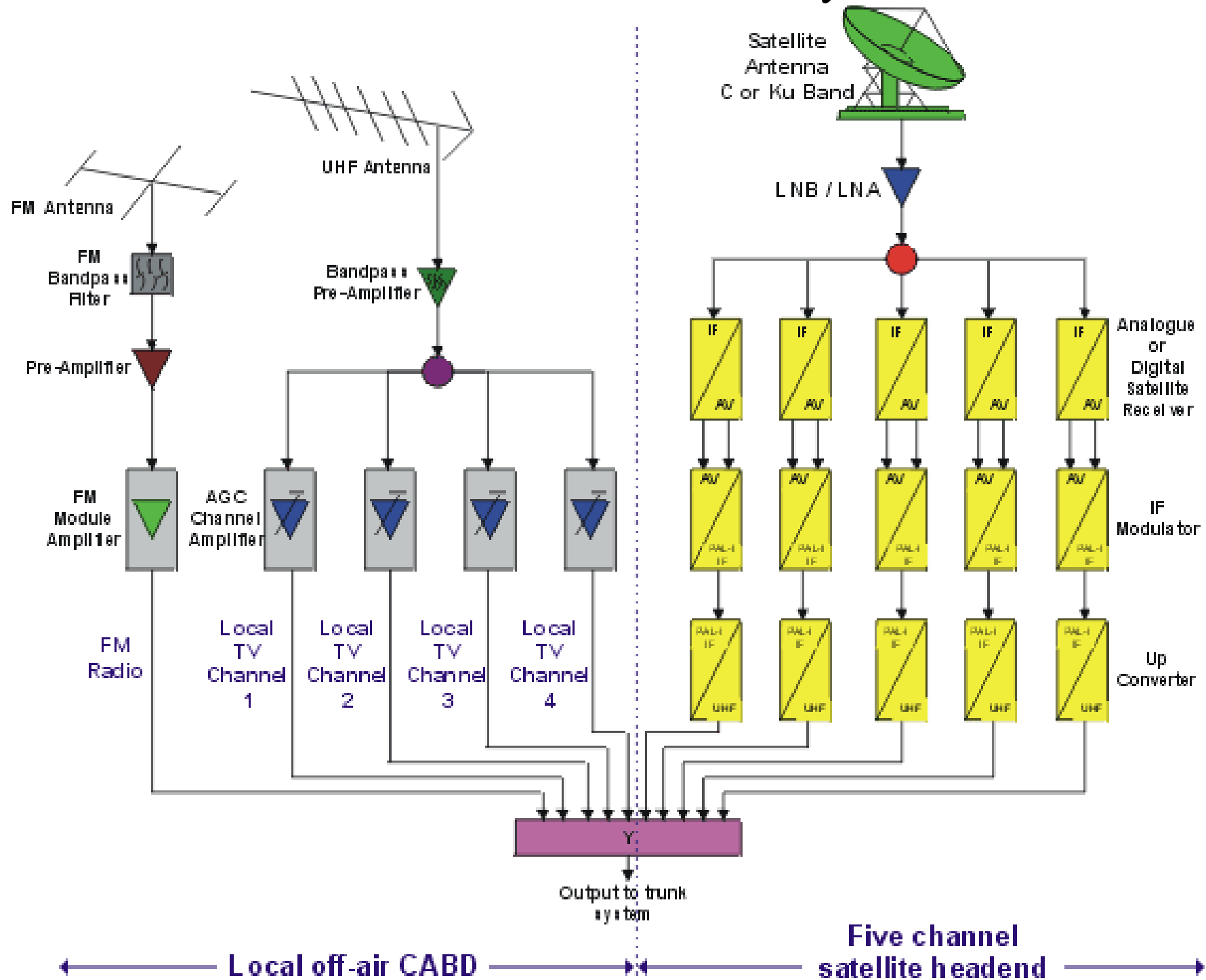
Satellite antenna television system



Dish = satellite dish

LNB = low noise block down converter

Satellite antenna television system



CABD and SMATV systems

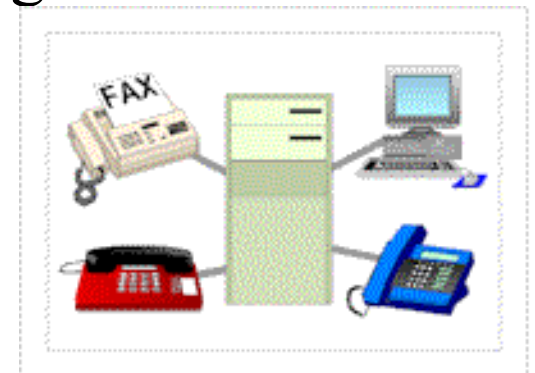


- Satellites receivable by SMATV systems in HK
https://www.ofca.gov.hk/filemanager/ofca/en/content/295/st_smatv.pdf
- Apstar 6C (亞太衛星6C), Apstar 7 (亞太衛星7)
- AsiaSat 5 (亞洲衛星5), AsiaSat 7 (亞洲衛星7)
- Chinasat 6A (中星6A), Chinasat 6B (中星6B)
- Intelsat 19 (國際19), Intelsat 20 (國際20)
- Measat 3/3a (馬星3/3a)
- Palapa D (印尼Palapa D)



PBX and PA systems

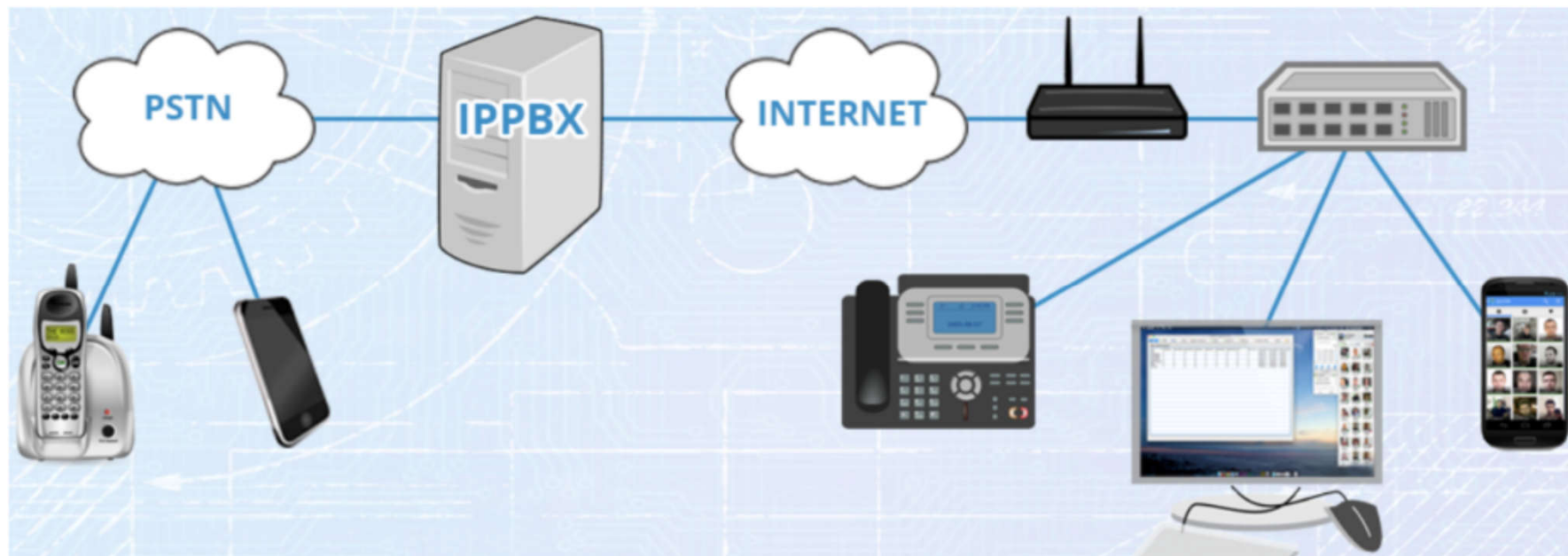
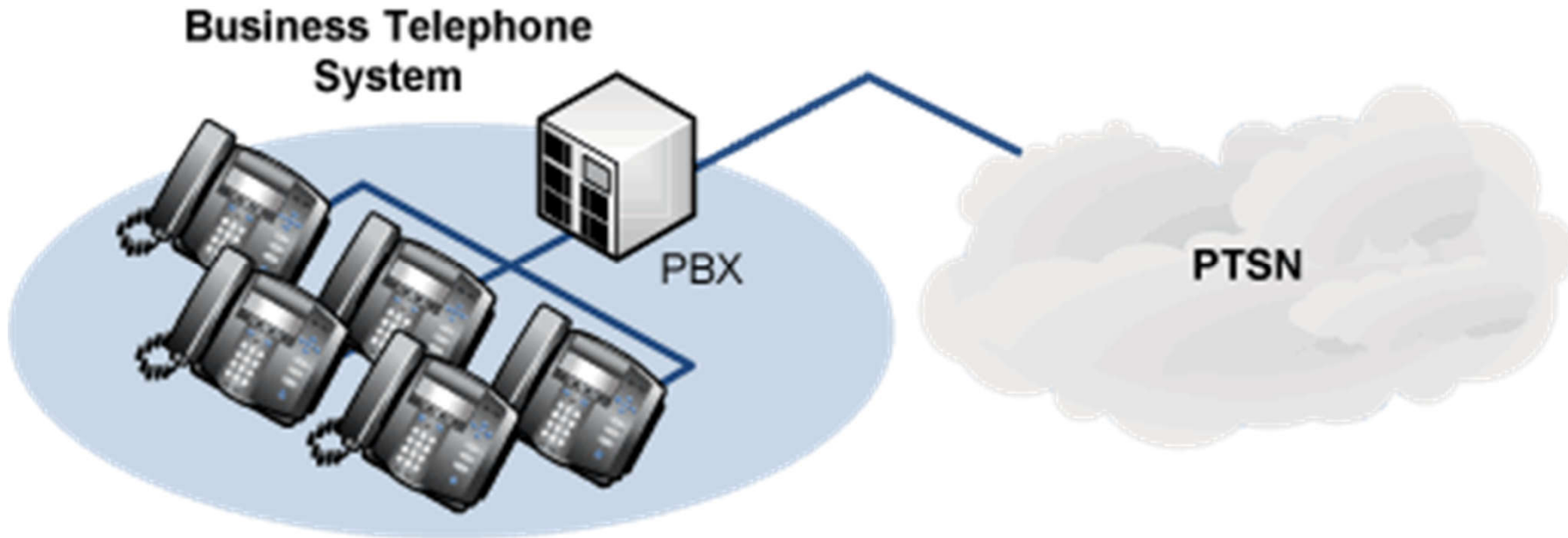
- Private branch exchange (PBX) systems
 - Also, private automatic branch exchange (PABX)
 - A telephone exchange that is owned by a private business, to allow all users to share a certain number of external phone lines
 - Main purpose: to save the cost of requiring a line for each user
 - Old PBXs use analog technology
 - New PBXs use digital technology



Video: What is PBX? (2021) (3:48) https://youtu.be/KviuXiNr_7w



Old PBX with publicly switched telephone network (PSTN) & “IPBX” uses Internet Protocol to carry calls



(Source: <https://www.businesstelephonesystem.org/pbx-telephone-systems-explained/>, <https://worlditpark.com/pbx-private-branch-exchange-in-telephony/>)



PBX and PA systems

- PBX performs three main duties
 - Establish connections (circuits) between the telephone sets of two users (e.g. mapping a dialled number to a physical phone, ensuring the phone isn't already busy)
 - Maintain such connections as long as the users require them. (i.e. channeling voice signals between the users)
 - Provide info for accounting purposes
- Other functions, e.g. call transfer

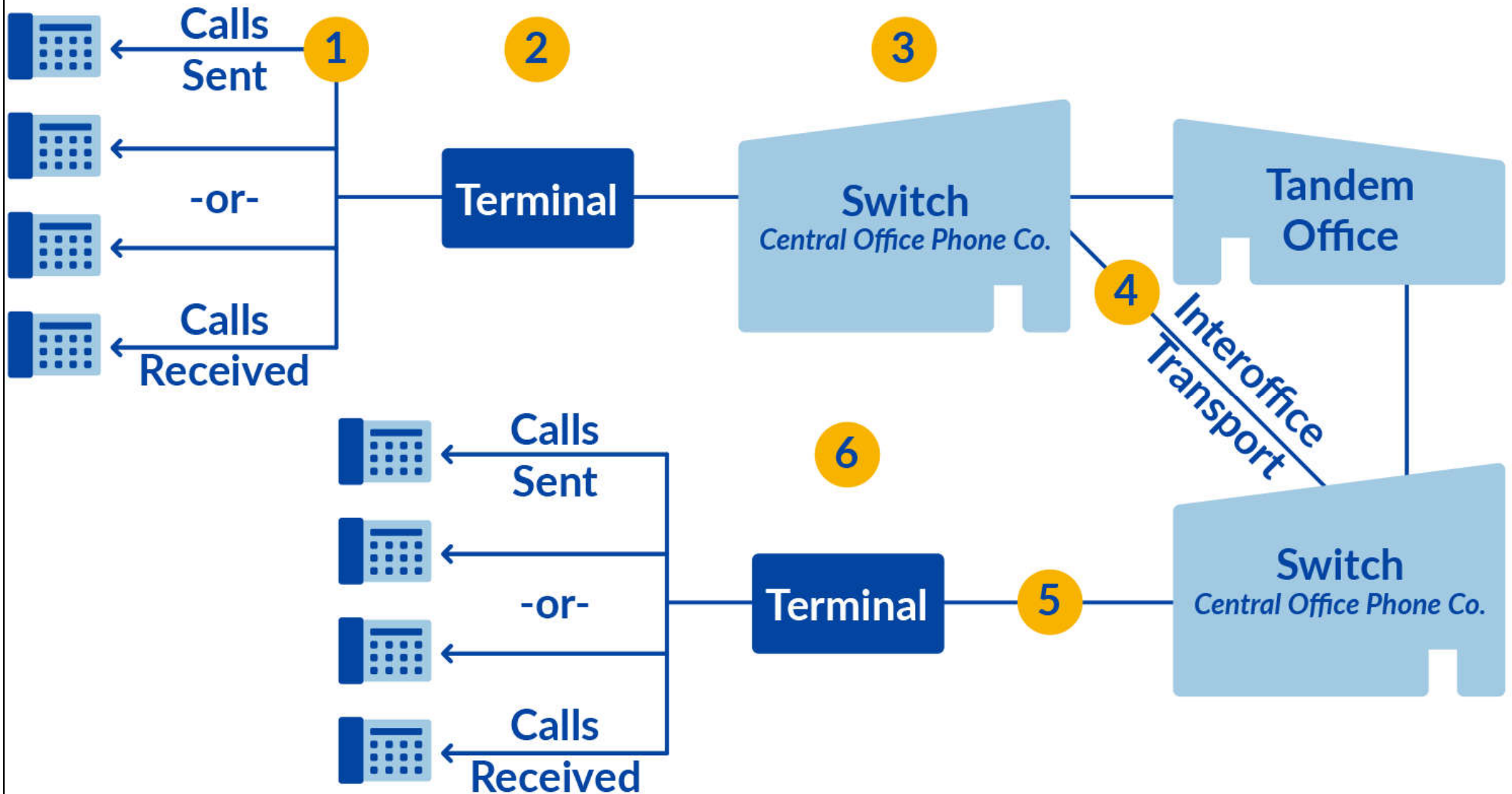




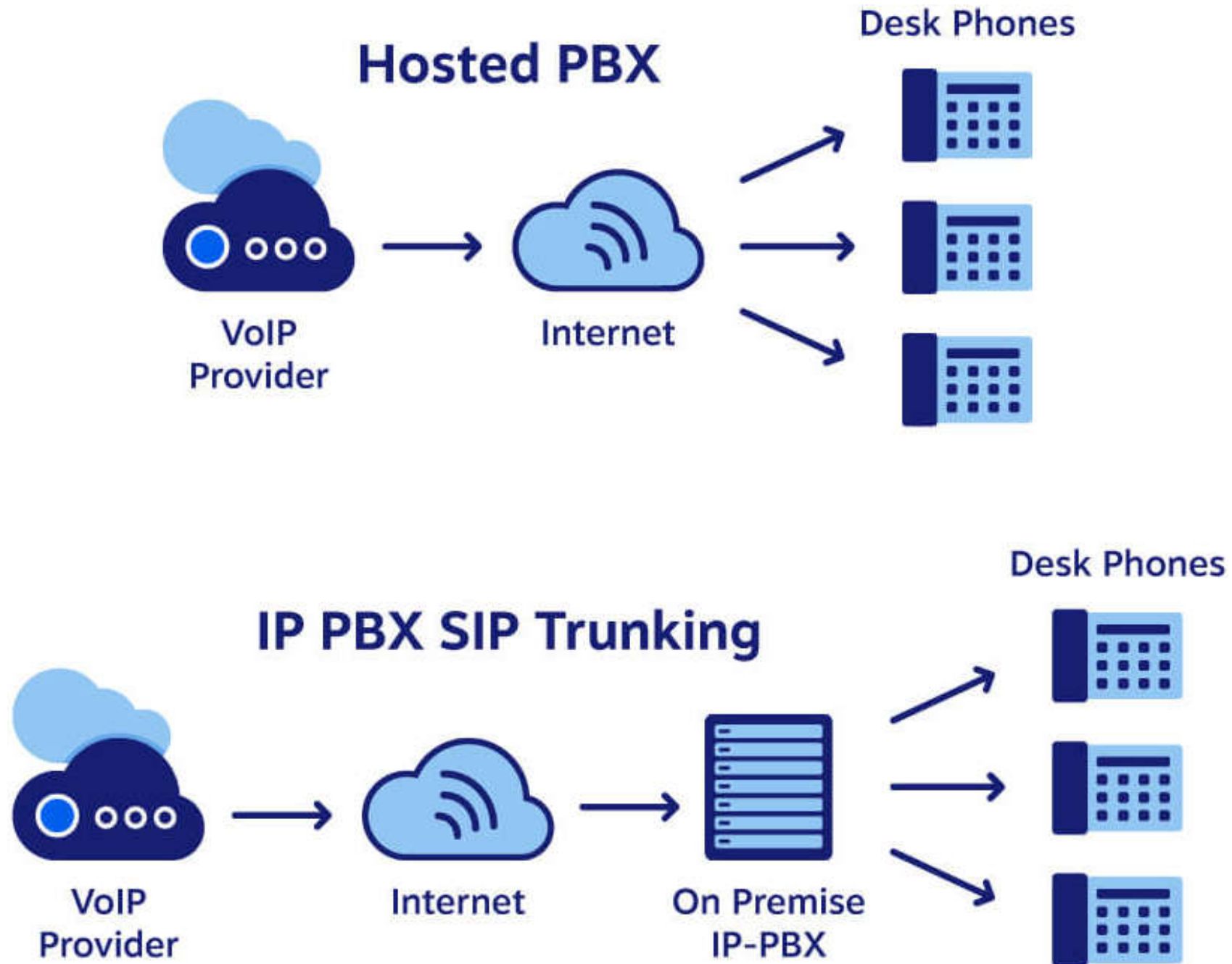
PBX and PA systems

- A PBX includes:
 - Telephone trunk (multiple phone) lines that terminate at the PBX
 - A computer with memory that manages the switching of the calls within the PBX and in and out of it
 - The network of lines within the PBX
 - Usually a console or switchboard for a human operator
- Larger manufacturers of PBXs:
 - Lucent Technologies, NORTEL, Rolm/Siemens, NEC, GTE, Intecom, Fujitsu, Hitachi, and Mitel
- Latest trends: “IPBX” uses Internet Protocol to carry calls, the use of cloud PBX (hosted/virtual PBX)

Plain old telephone system using publicly switched telephone network (PSTN)



New PBX system using Internet Protocol (IP), Session Initiation Protocol (SIP) & Voice over Internet Protocol (VoIP) technology





PBX and PA systems

- Public address (PA) systems

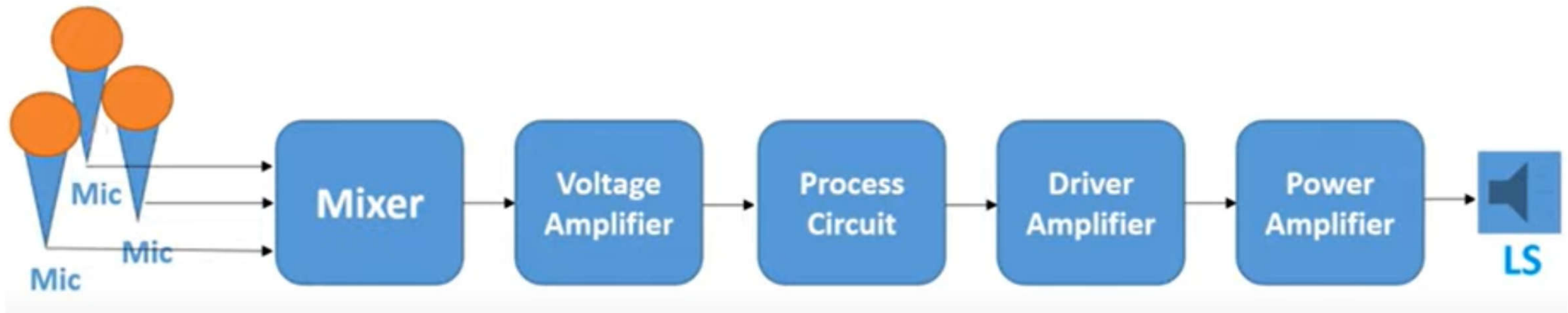
擴音系統

- Also known as “Tannoy”
- An electronic amplification system used as a communication system in public areas

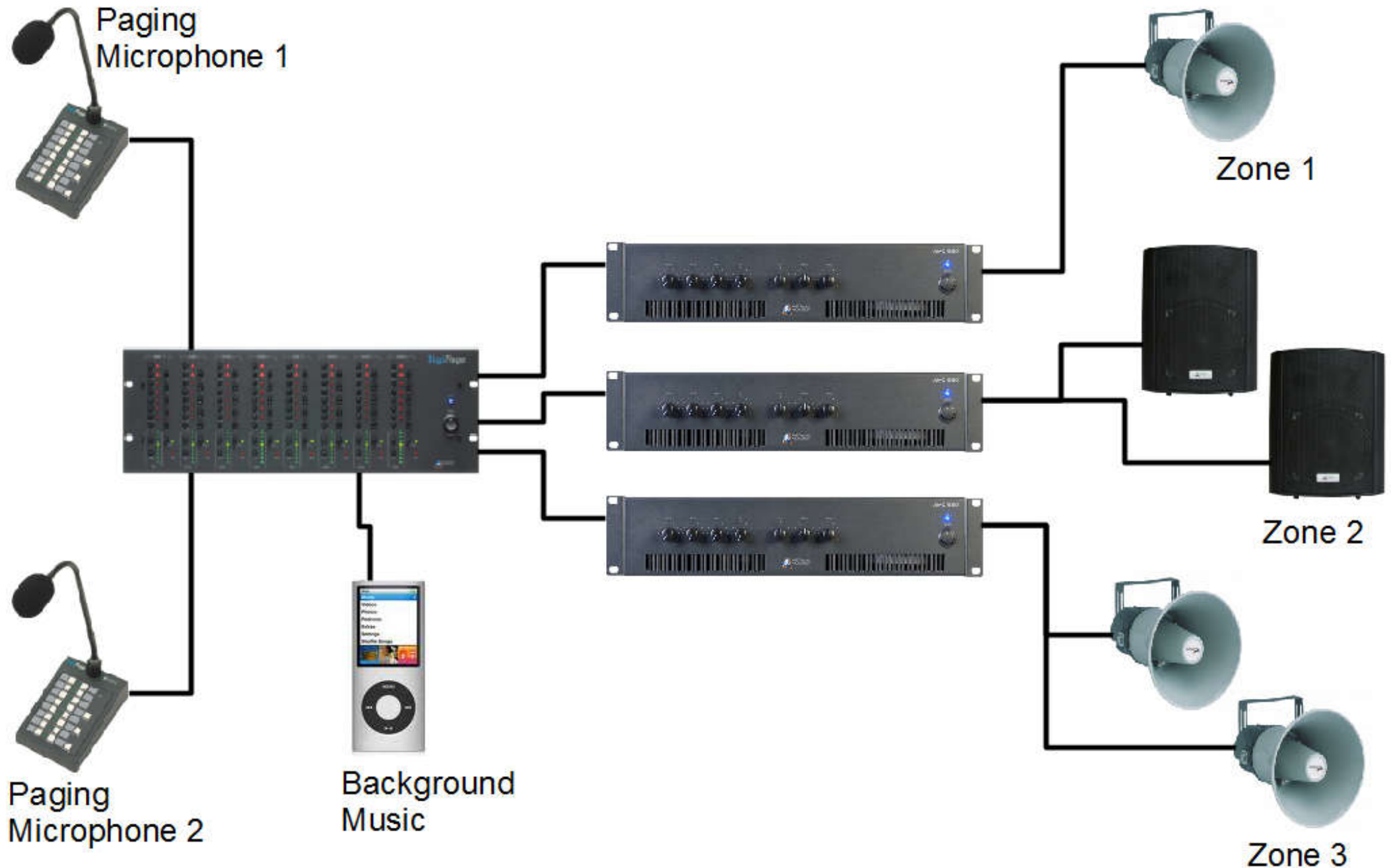


- Amplifier, loud speaker & mixer for sound control
- Can be fixed or portable, indoor or outdoor
- For general announcement, background music or emergency messages
- Details of equipment are determined by discussion with the manufacturers

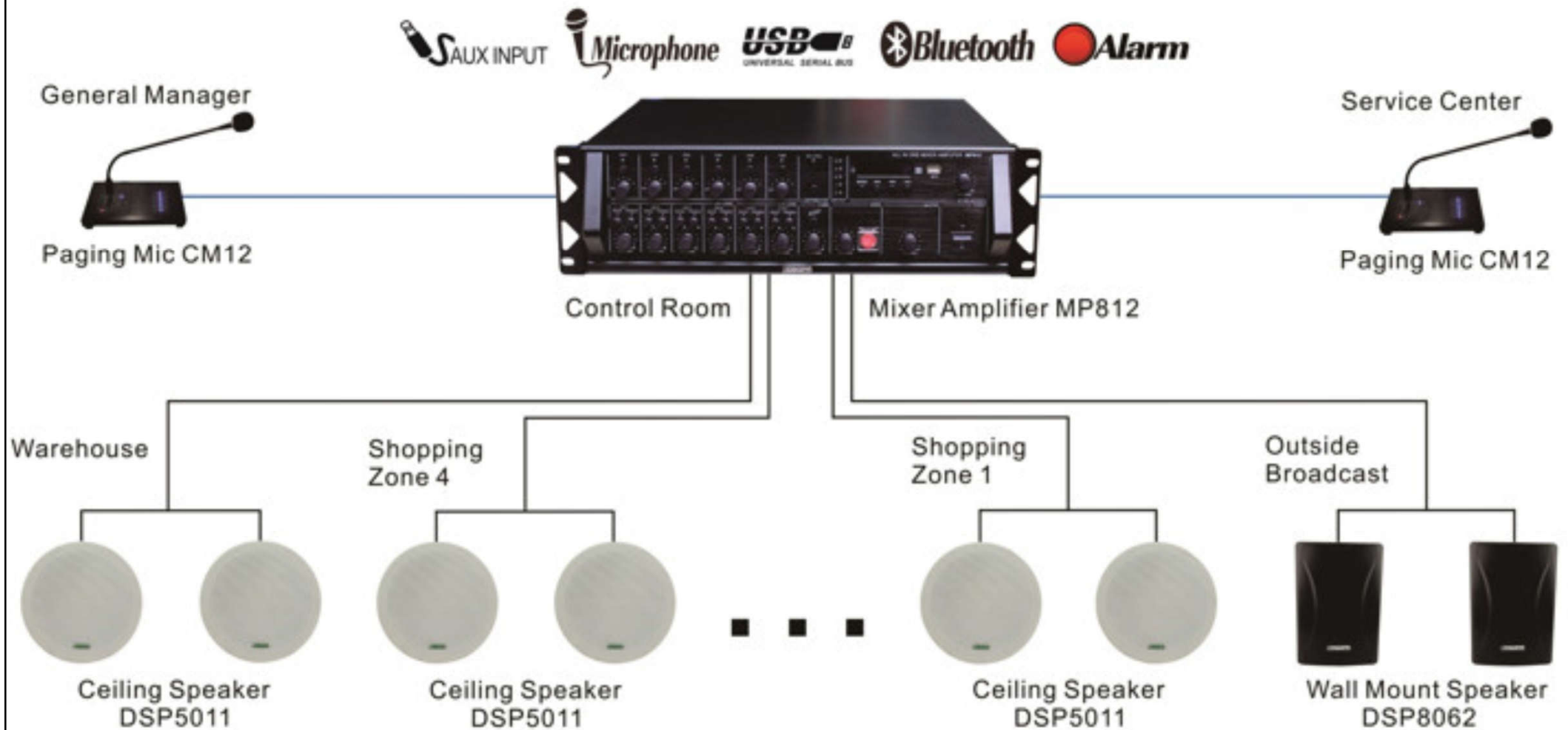
Examples of public address (PA) systems



Public address (PA) system with electronic sound amplification & distribution



An examples of public address (PA) system for shopping centre



PBX and PA systems



- Public address (PA) systems

- Typical PA components for assembly hall or playground in schools:

- Microphone complete with floor-stand
- Cassette deck
- Mixer power amplifier
- Column speakers (for assembly hall) and horn speakers (for covered playground)
- Monitor speaker
- Wooden Cabinet for housing the items



Do you know
how to select &
plan the PA
systems?



PBX and PA systems

- Basics of public address (PA) systems
 - Intensity of sound decreases with distance
 - Amplification is required for comfortable listening
 - For better understanding, sound quality is crucial
 - PA system can improve sound quality in big space
 - It is used in sports meet, public meetings, auditoriums, concerts, functions, etc.
 - Ambient noise, acoustic feedback & reverberation

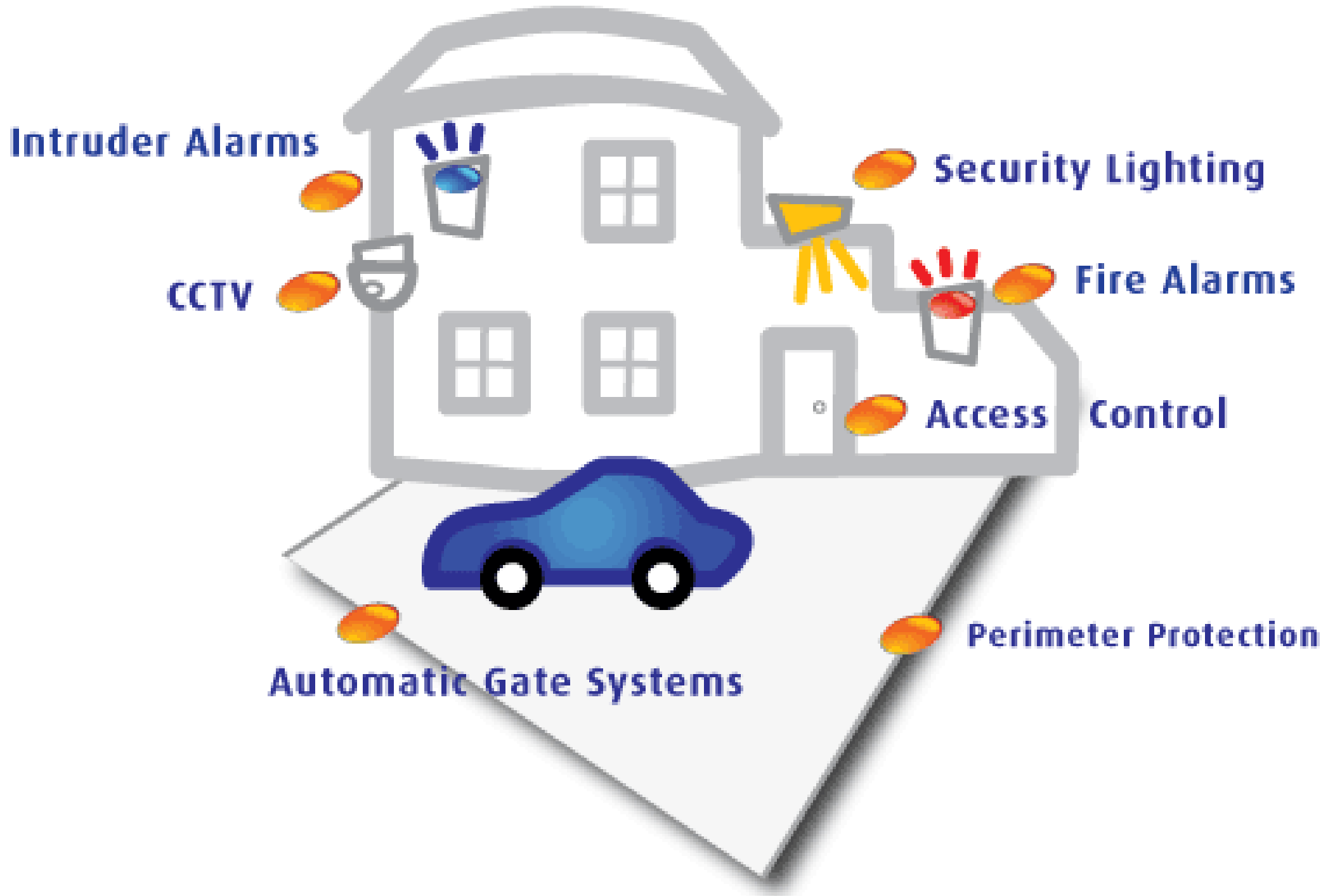
Security systems



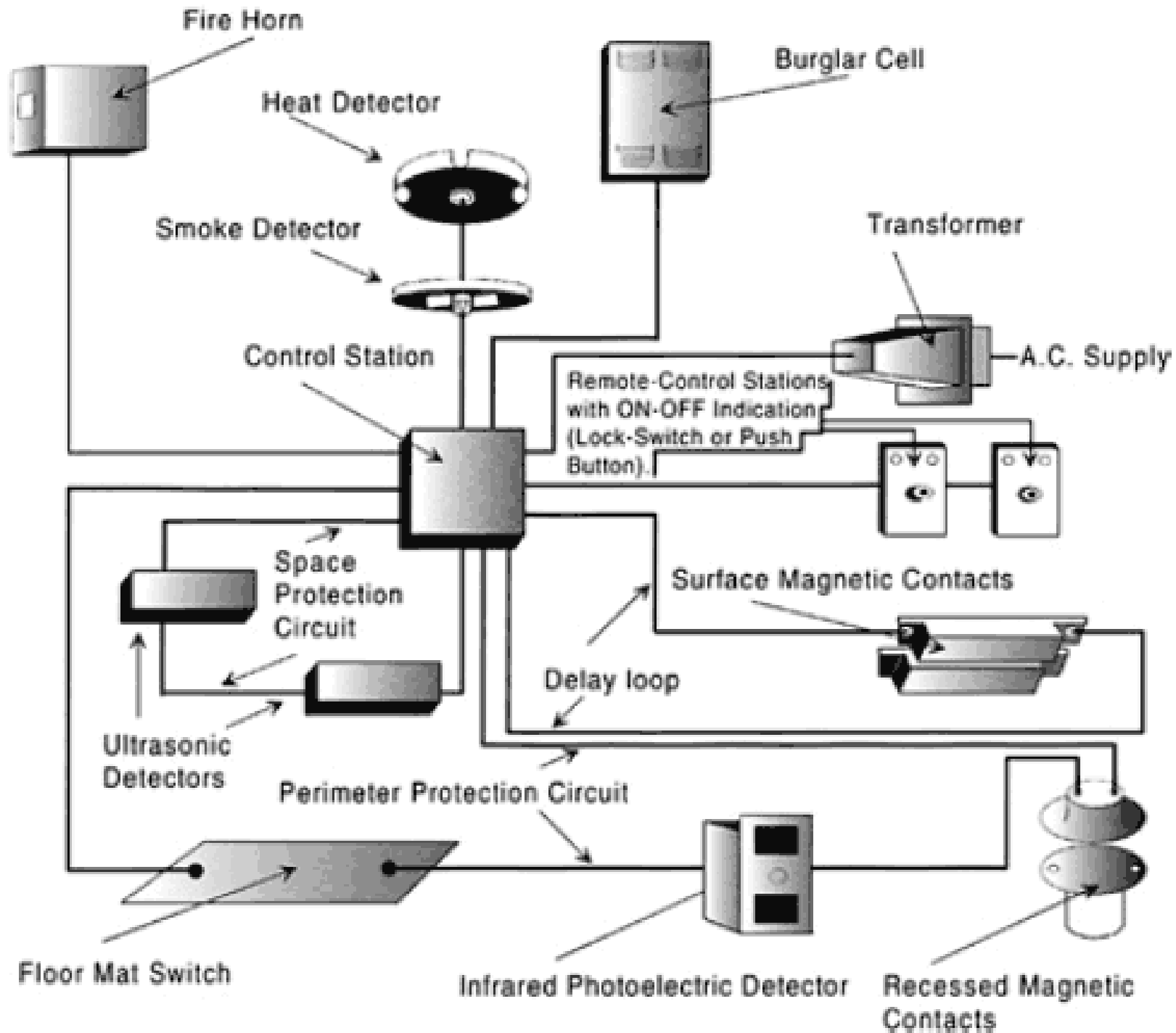
- Electronic security systems 電子防盜系統
 - For security operations like surveillance, access control, alarming or an intrusion control
 - Applied to residential buildings, workplaces, commercial places, shopping centres, and public places like railway stations & traffic management
 - Often work together with fire alarm/detection & building automation/management systems



Security and alarm systems



Components for a typical security/fire-alarm system



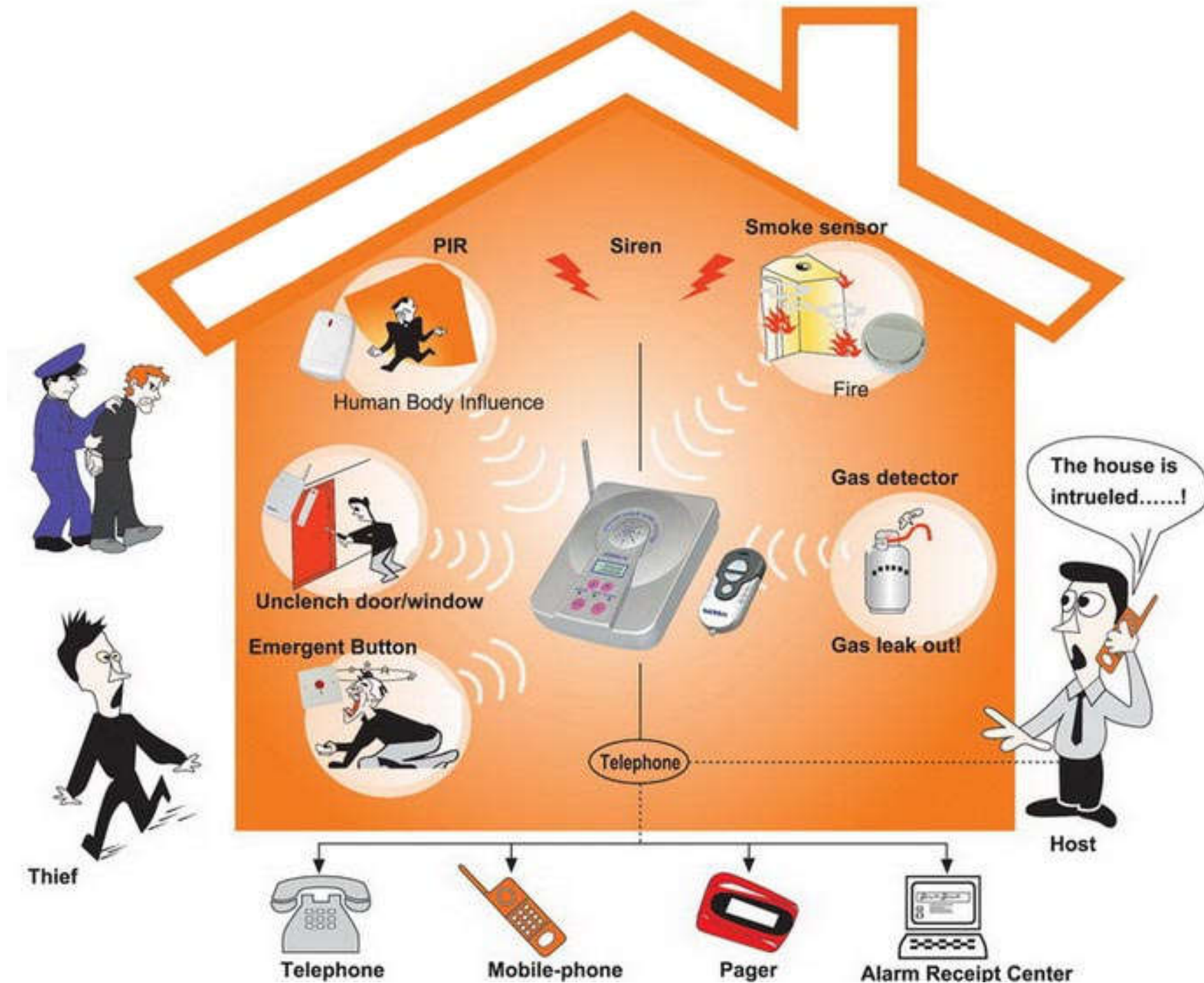
(Source: Kennedy, T. and Traister, J. E., 2002. *Low Voltage Wiring: Security/fire Alarm Systems*)



Security systems

- Common types of security systems
 - Burglar alarm system
 - Central or local (w/ direct link to police)
 - C.C.T.V. surveillance system
 - Intruder detection & access control
 - Intercom systems (audio/video)
 - Door-phone system & interlocking system
 - P.A. (panic attack) button & sound system
 - Security lighting
 - Guard tour/monitoring system

Example of home security system



Typical components of security and alarm systems



Intrusion Alarms



Closed Circuit Television



Digital Video Surveillance

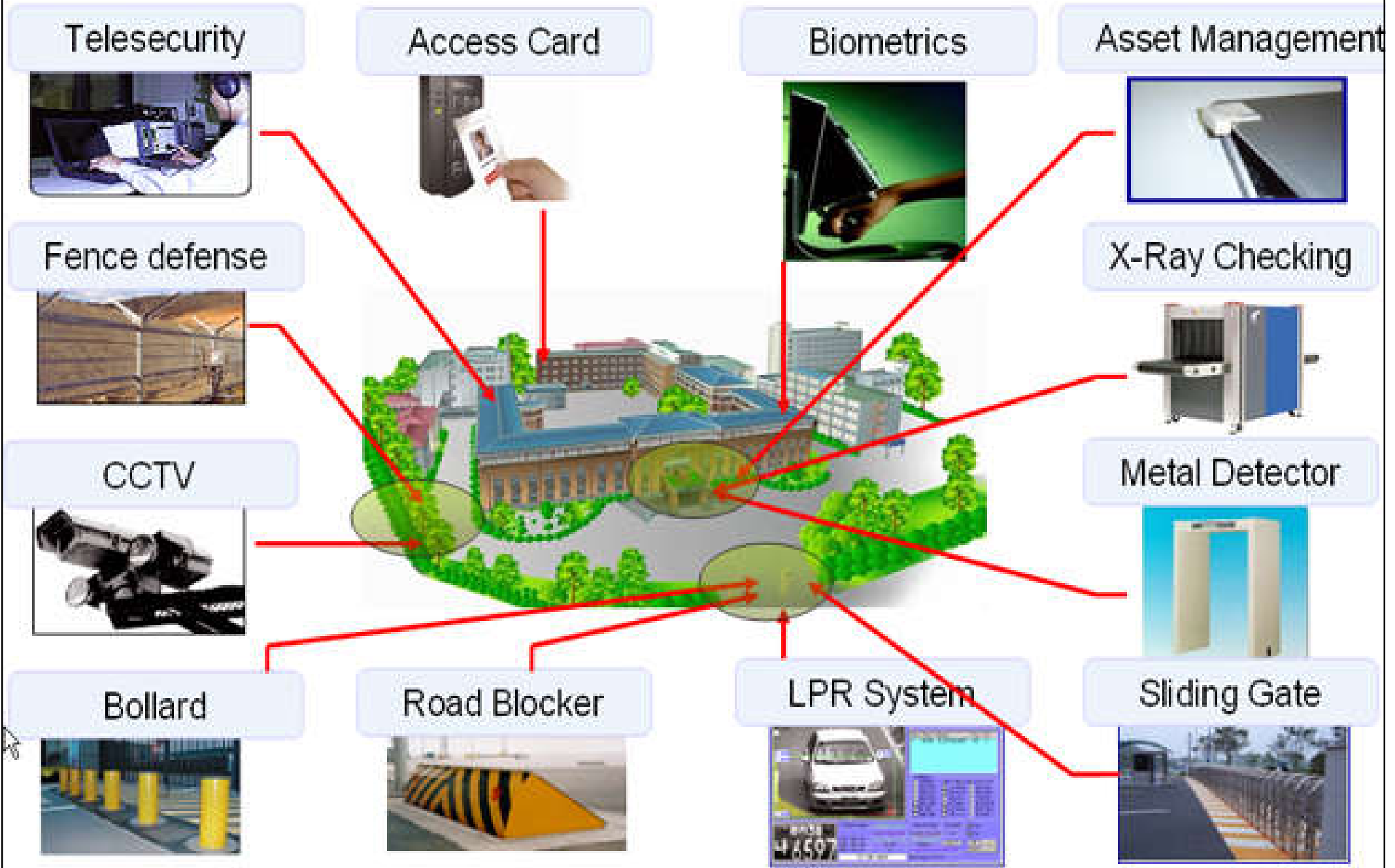


Access Control



Critical Process Monitoring

Integrated security in a typical building management solution



Example of a highly secured premise in Hong Kong



CCTV

Security control
centre



Access
control



Blocks &
fencing



A typical building security & car park control system



- (1) Building entry access system with intercom system
- (2) Lift access control restricting tenants within floors
- (3) Secure alarmed areas within office complexes
- (4) Energy management & building service control systems (lighting and air conditioning)
- (5) Car park access control for entry and exit

(Source: <http://www.baps.co.nz>)

Security systems



- Security Products (HK Police Crime Prevention)
http://www.police.gov.hk/ppp_en/04_crime_matters/cpa/sec_products.html
 - Access control systems, alarms, CCTV
 - Guard monitoring systems
 - Security lighting
 - Locks
 - Perimeter protection (fencing, barriers)
 - Personal panic alarm
 - Property marking
 - Screening, storage
 - Vehicle security system

Are you
aware of the
security
products
around us?

Security systems



- Security company licence in HK
 - Type I – provision of security guarding services
 - Type II – provision of armoured transportation services
 - Type III – installation, maintenance and/or repairing of a security device and/or designing (for any particular premises or place) a security system incorporating a security device
- Managed by the Security and Guarding Services Industry Authority (SGSIA)



<http://www.sb.gov.hk/eng/links/sgsia/>



CCTV systems



- Closed circuit television (CCTV) system 閉路電視

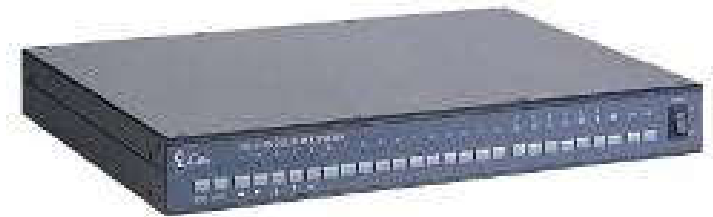
- Functions

- 24 hour surveillance/deterrence
- Real time or time lapse recording (on a closed loop basis)
- Motion/alarm activated monitoring & recording
- Area search using remotely controlled cameras
- Integration with access control & other security systems

- Components (now mainly digital)

- Video camera (colour or monochrome)
- Monitors, recorders and switchers
- Multiplexer (triplex operation simultaneous playback and recording)

- Key factors: quality, storage, export, playback



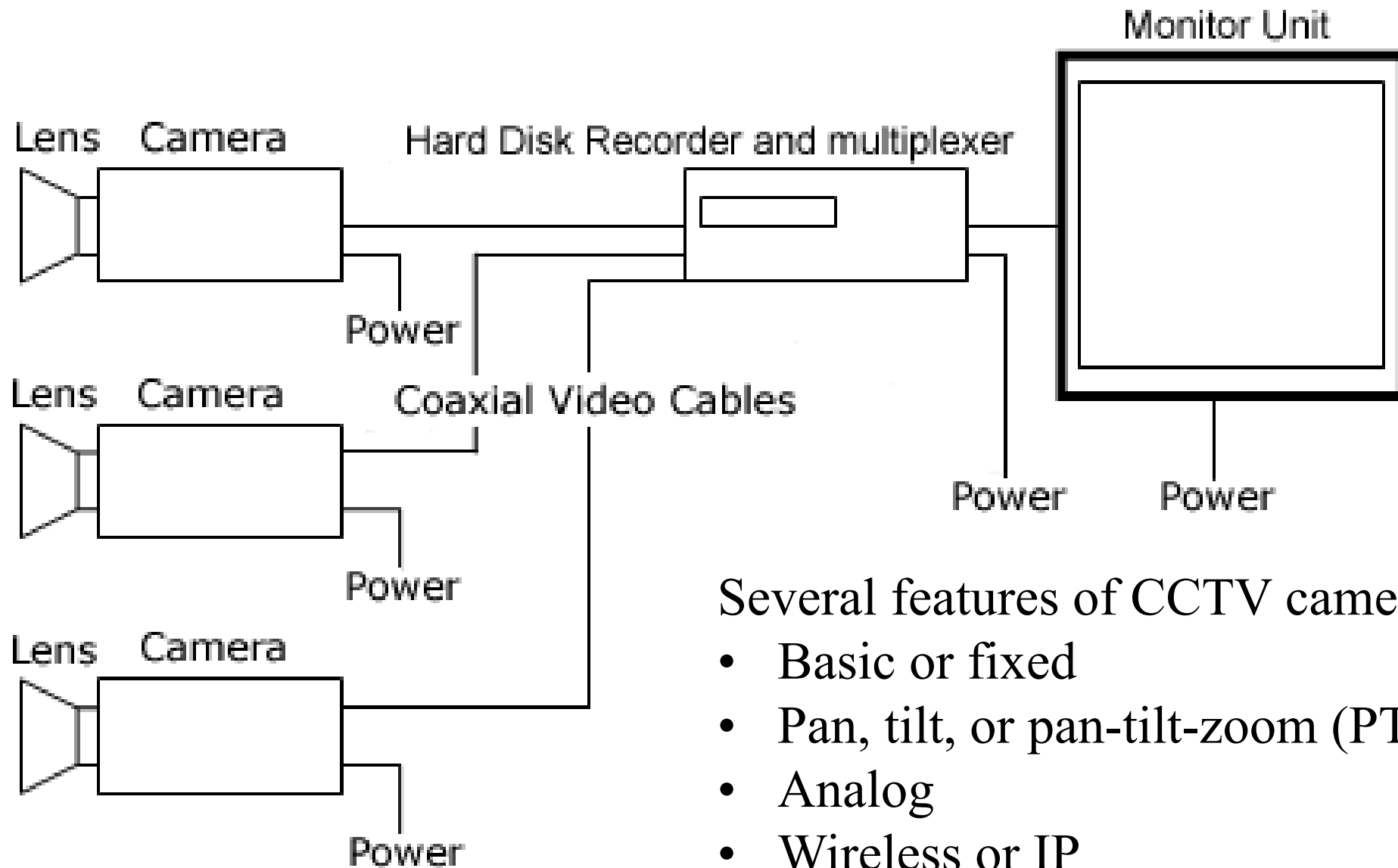
Different types of CCTV cameras



Types of cameras:-

- Dome camera
- Bullet camera
- Fisheye camera
- C-Mount camera
- Pan-tilt-zoom (PTZ) camera
- Day/Night camera
- Thermal camera
- Infrared/Night vision camera
- Network/IP camera
- Wireless camera
- High-definition HD camera

Basic concept of a multi-camera CCTV system



Several features of CCTV cameras:

- Basic or fixed
- Pan, tilt, or pan-tilt-zoom (PTZ)
- Analog
- Wireless or IP
- Night vision
- Exterior
- Motion-detection



CCTV systems

- Uses of CCTV systems:
 - Crime prevention (and deterring)
 - Crime investigation (a forensic tool)
 - Vehicle traffic monitoring (e.g. in car parks)
 - Pedestrian traffic (crowded) monitoring
 - Allow drivers to confirm people are clear of doors
 - Monitor access to secure or private areas
 - Employee/staff monitoring
 - Video surveillance in schools, shops or homes

The resolution makes a big difference – comparing CCTV cameras



(Source: <https://kintronics.com/ip-cameras-better-analog-cctv-cameras/>)



CCTV systems

- Technological advances of CCTV systems:
 - Video at full-colour & high-definition
 - Compression & storage of recordings
 - Save to the cloud via wired or Wifi network
 - Video content analysis (e.g. artificial intelligence)
 - Facial & image recognition, behaviours (suspicious or violent activities)
 - Internet protocol (IP) cameras
 - Wireless & networking security cameras
 - Talking CCTV (by the operator)

Do you know
the potential
of CCTV for
image
recognition?

Behavioral recognition by using CCTV video content analysis



Violent Activity Recognition



Environment Safety



Traffic Monitoring

Violent Activity

- People fighting
- Brawl/Riot
- Vandalism
- Person with blood
- Person with weapon

Suspicious Activity

- Contextual loitering, tailgating
- Person abandons an object
- Person with mask /no mask
- Person running/walking/falling
- Person gets in/out of a vehicle

Person & Crowd Behaviour

- Crowd classification by size
- Crowd moving /gathering /dispersing
- Occupancy analytics
- Person to person proximity

Perimeter Protection

- Person entering/exiting predefined zone
- Vehicle entering/exiting predefined zone

Traffic Monitoring

- Vehicle counting & classification
- Vehicle behaviour
- Accidents & hazards recognition
- Urban mobility (vehicle+person)
- Traffic congestion

Environment+Personal Safety

- Smoke/Fire
- Person with/without safety equipment
- Person/Equipment in hazard
- Person falling/on the ground



Video understanding for security and surveillance (3:04)

<https://www.viisights.com/products/wise/>

(Source: <https://www.viisights.com/>)

Internet-based CCTV systems

CCTV Cameras



LCD Monitor



Television



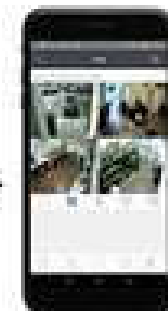
Digital Video Recorder



Internet



Remote PC



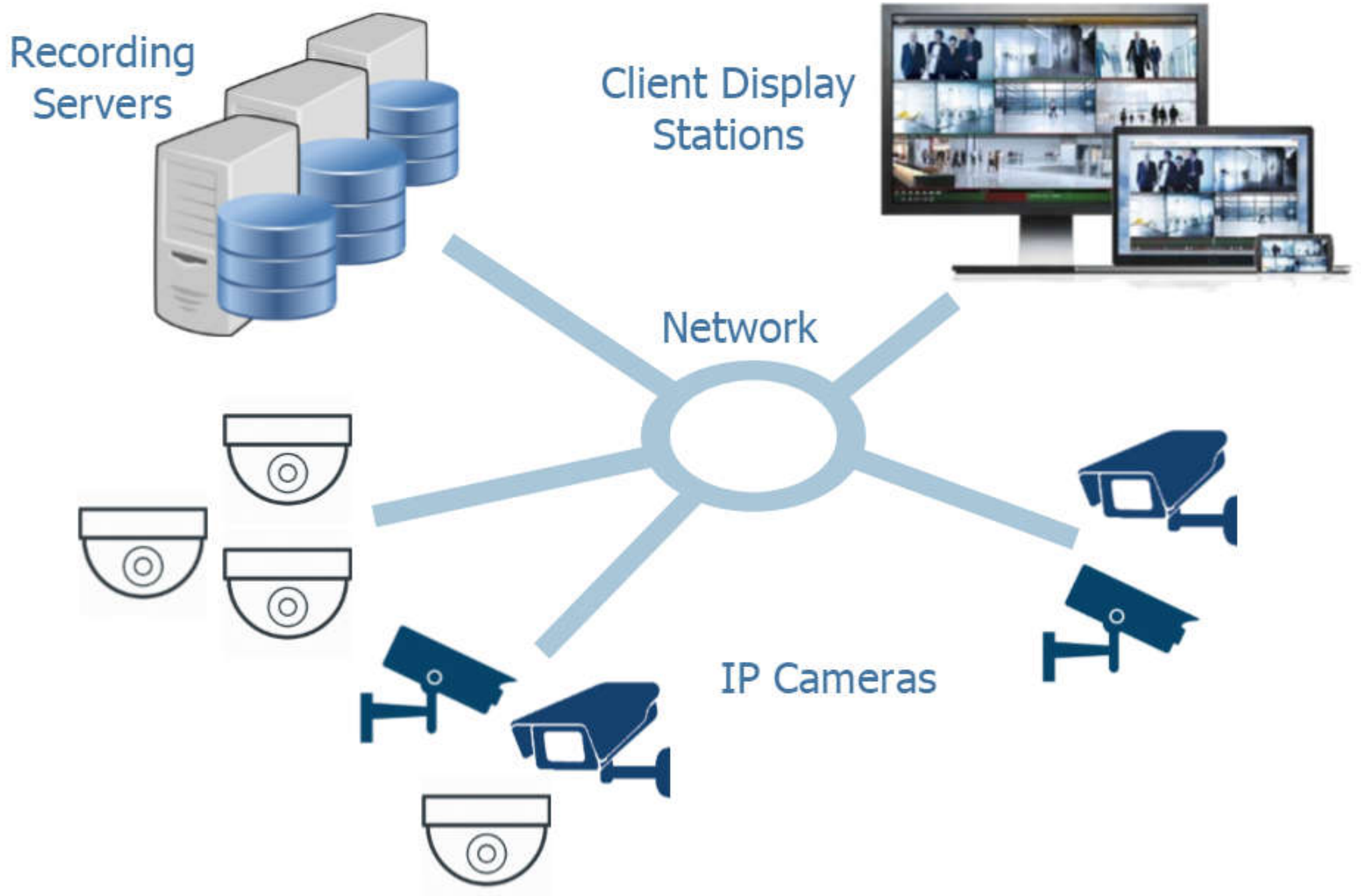
Smartphone/Tablet



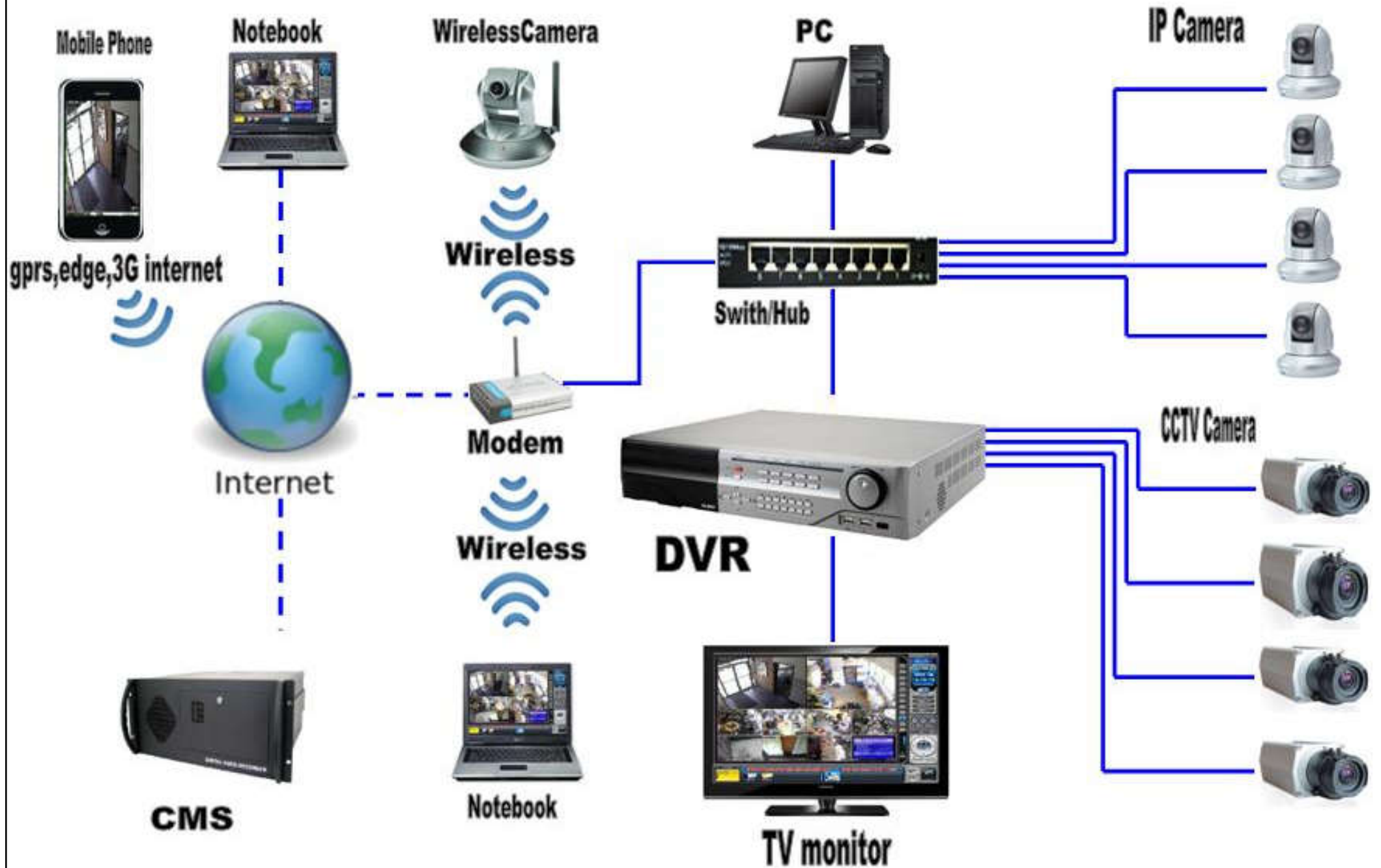
CCTV systems

- Internet protocol (IP) cameras
 - Connect to the network rather than to a digital video recorder (DVR) using a coax cable
 - The IP camera system includes not only the cameras but also the video recording system
 - Network infrastructure
 - Power over Ethernet (PoE): enough power to support IP devices
 - Video management & recording system
 - Network video recorders (NVR)

IP camera system diagram



Examples of CCTV installations with wireless, IP & analogue cameras



Talking CCTV - the system's operator can challenge criminals or members of the public via an intercom system (help stop antisocial behaviour)



Access control systems



- Access control

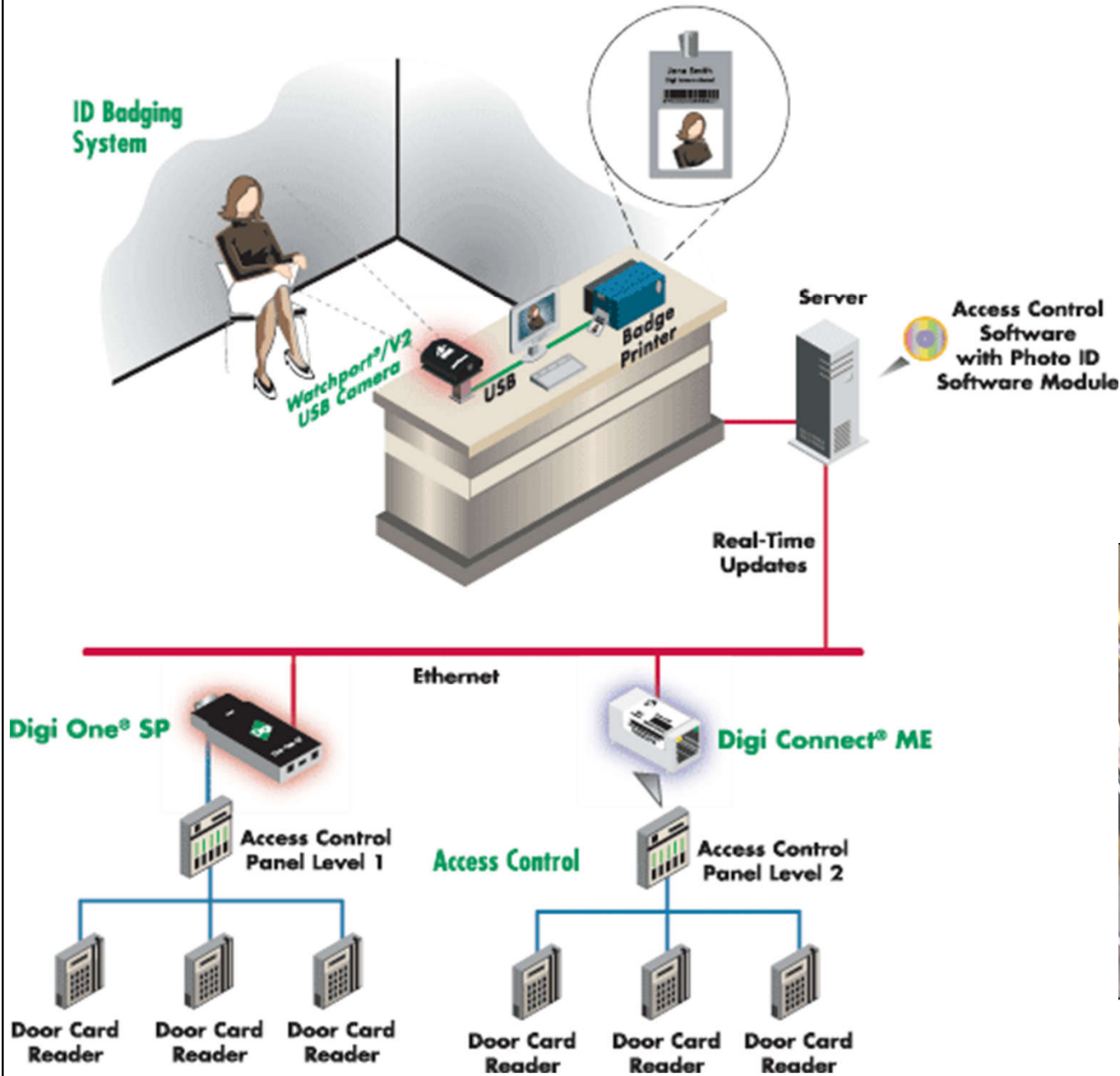
- Stand-alone or online systems
- Methods:
 - Digital codes
 - Magnetic stripe cards
 - Embedded wire cards
 - Proximity cards/tags
 - Biometric access control (e.g. retina, finger prints)
- Pedestrian turnstiles (like those in subway stations)
- Car park control (e.g. car park ticket validation)



Access Control Terminal



Integrated Photo ID Badge and Access Control System

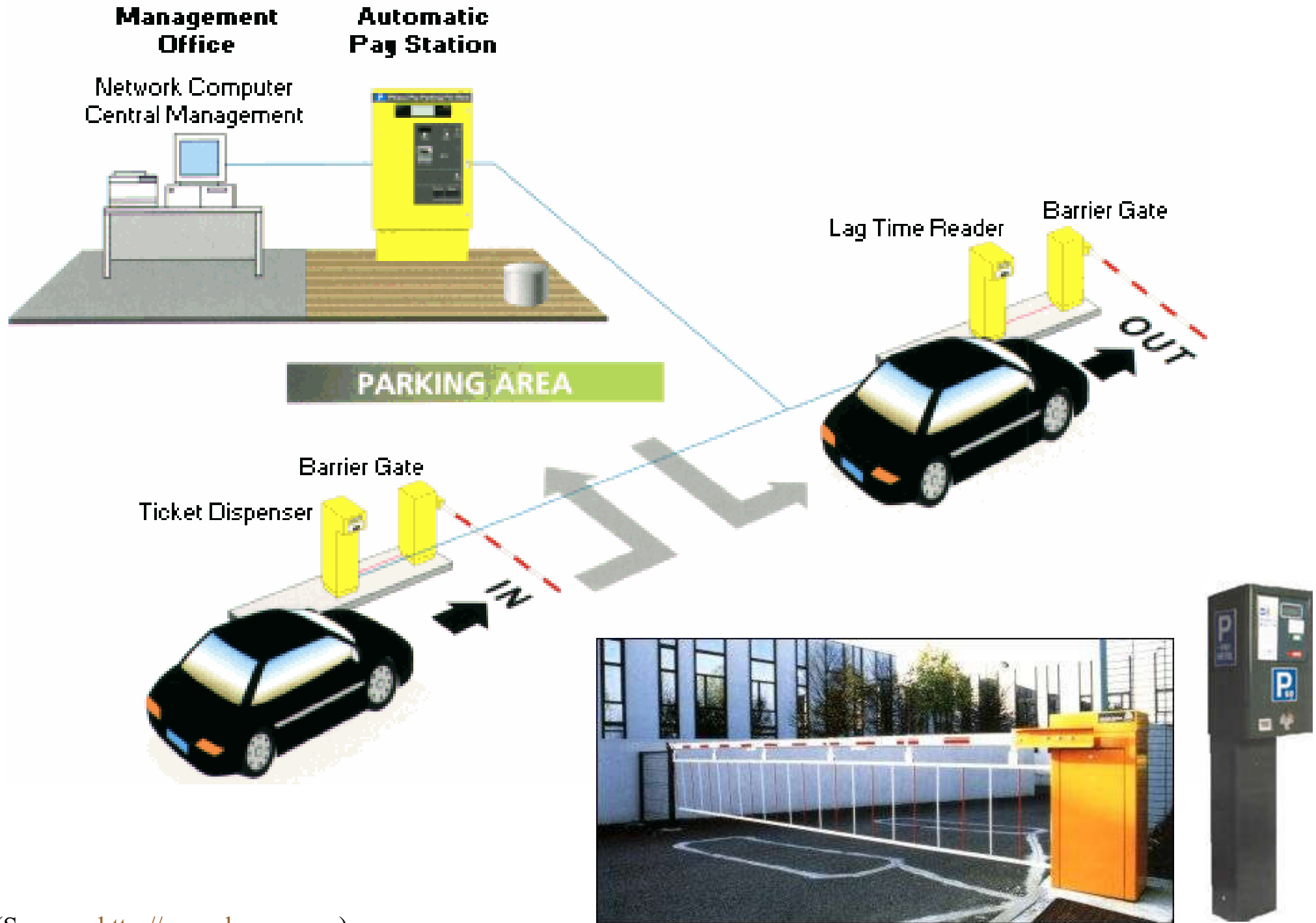


Access control system



Pedestrian turnstiles

Car park control system



Access control systems

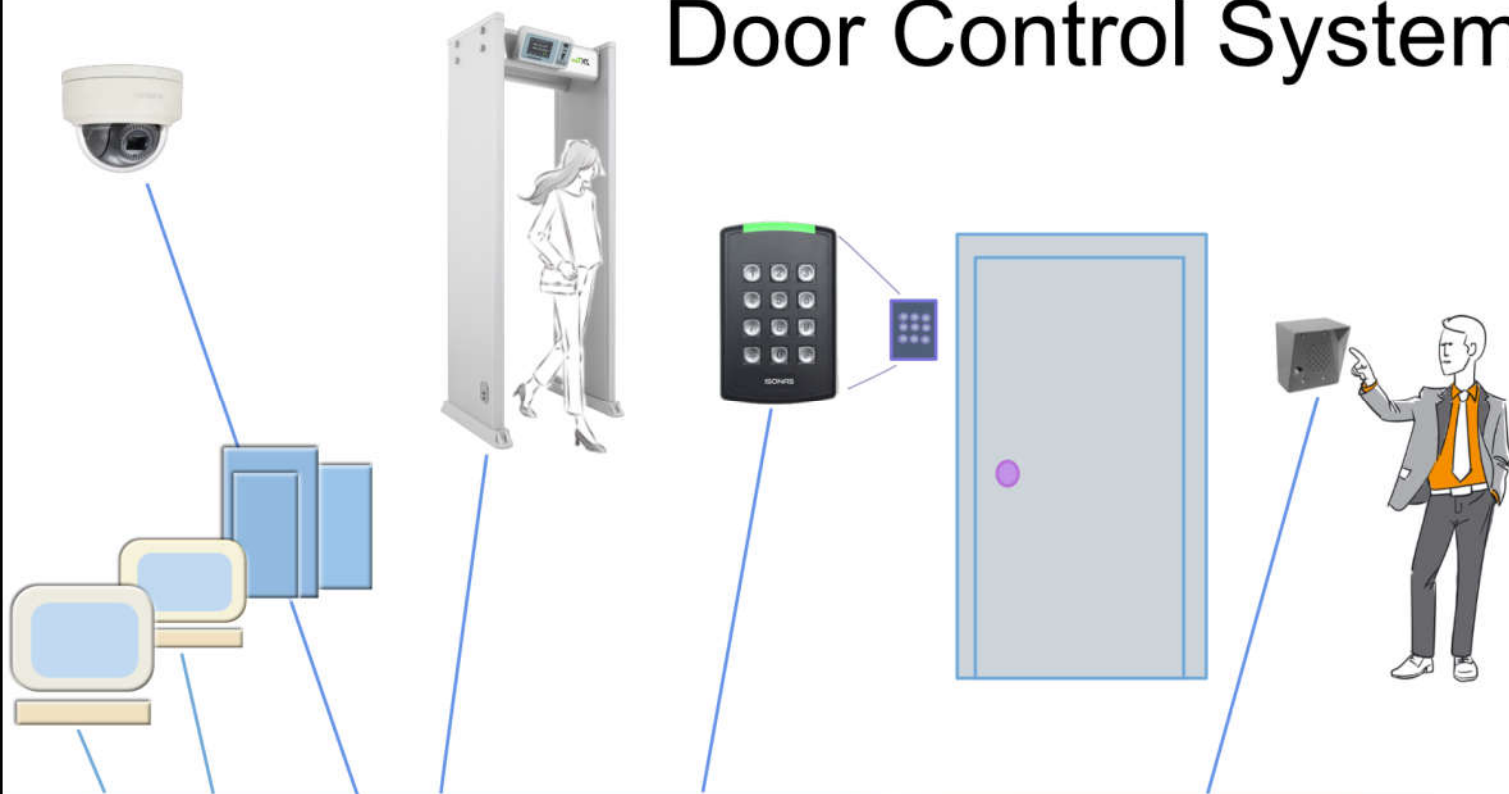


- Access control system (ACS)
 - Control passage into or out of any area
 - Computer-based, electronic access control
 - Basic components:
 - Access cards
 - Card readers
 - Access control keypads
 - Electric lock hardware
 - Access control field panels
 - Access control server computer
 - Latest trend: wireless & cloud-based systems



Examples of door access control systems (with door control readers, metal detectors, intercoms, IP cameras & emergency paging system)

Door Control Systems



What are the key factors for door access control?



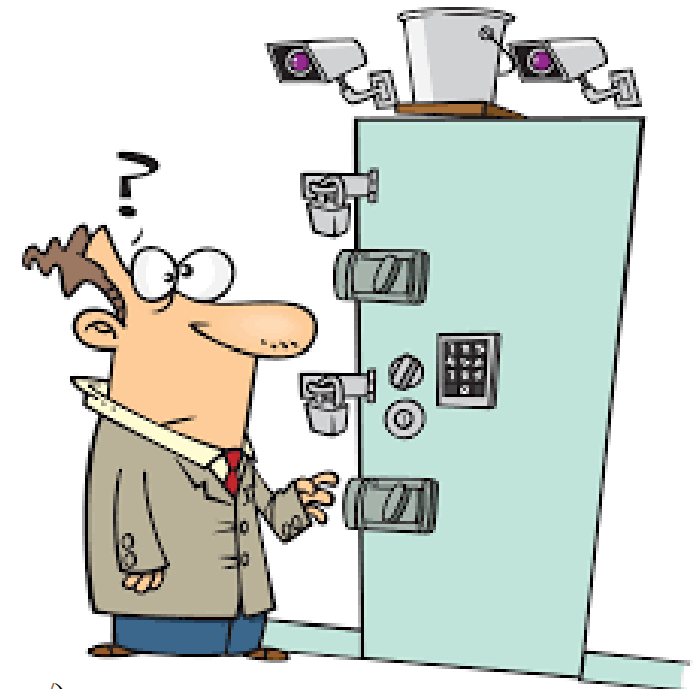
Various levels of security for door access control systems

Level 1 Security – PIN Numbers	Lock with keypad Door Reader with keypad
Level 2 Security – Credentials	RFID IP Reader
Level 2.5 Credentials With Video	Intelligent IP Reader
Level 3 Security – Dual Authentication Systems	RFID IP Reader
Level 3.5 Dual Authentication Plus Video	Intelligent IP Reader with Keypad
Level 4 Security – Biometric Readers	Biometric IP Reader
Level 4.5 Biometric Readers Plus Video	

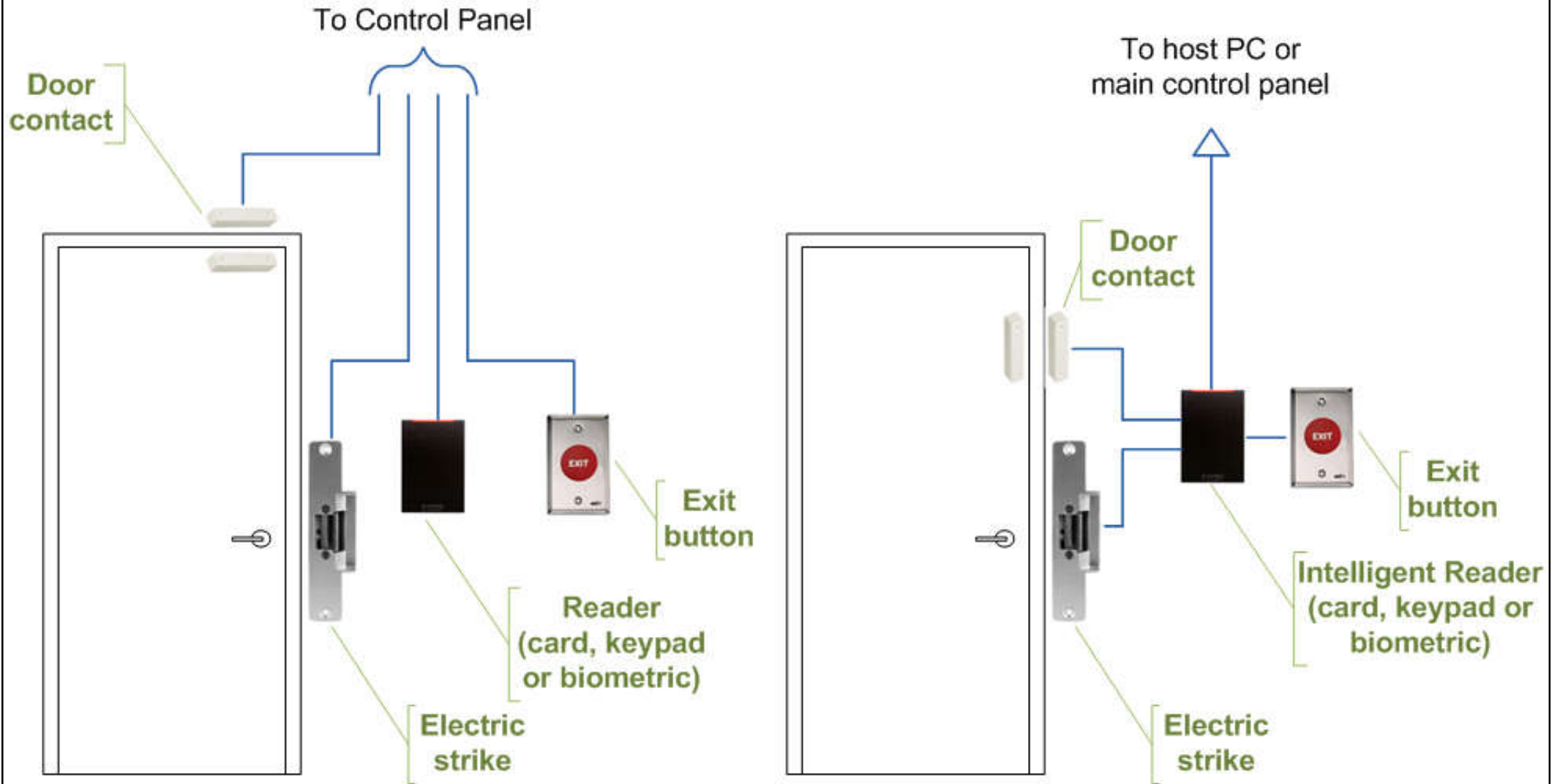
PIN = Personal identification numbers

RFID = Radio frequency identification

IP = Internet protocol



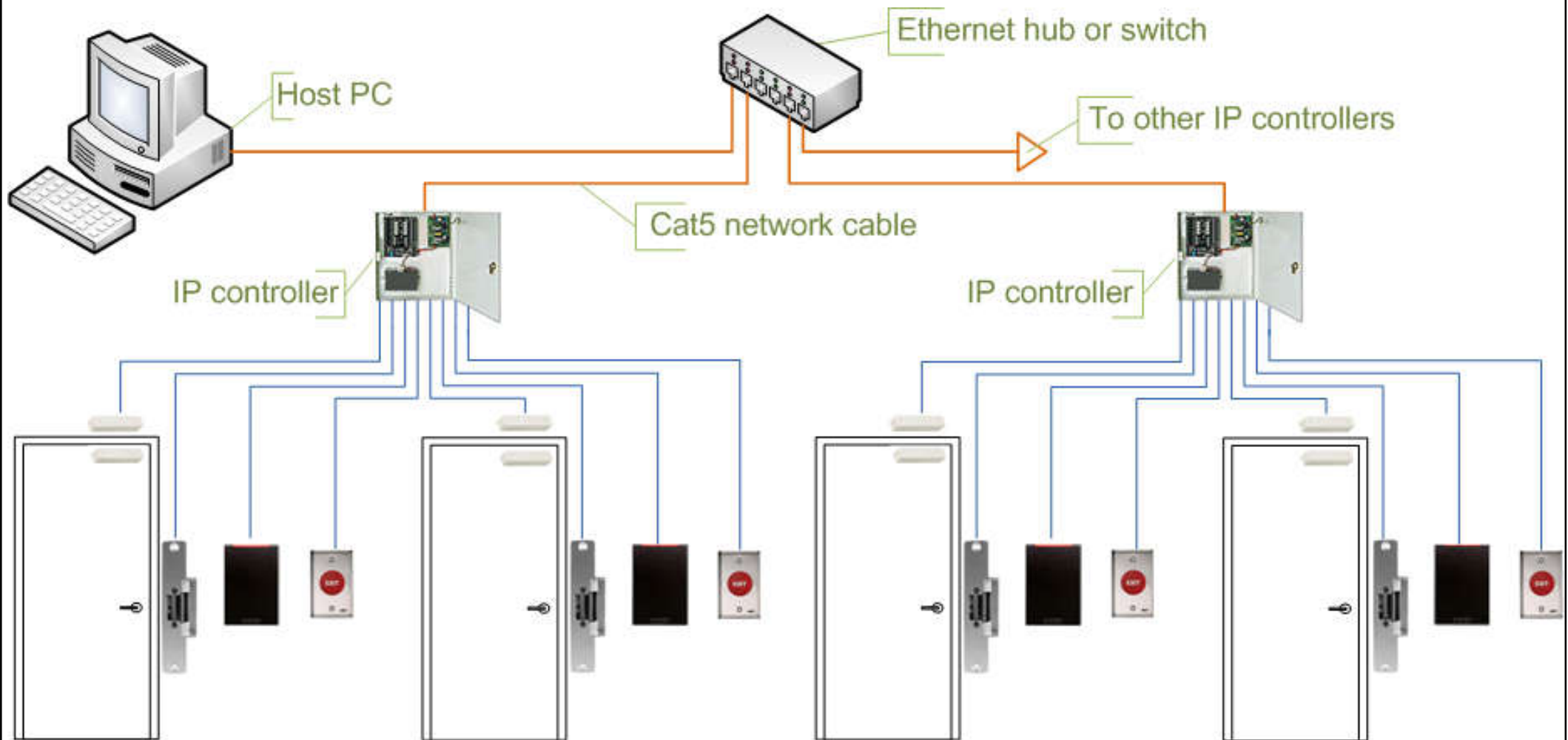
Typical access control door wiring



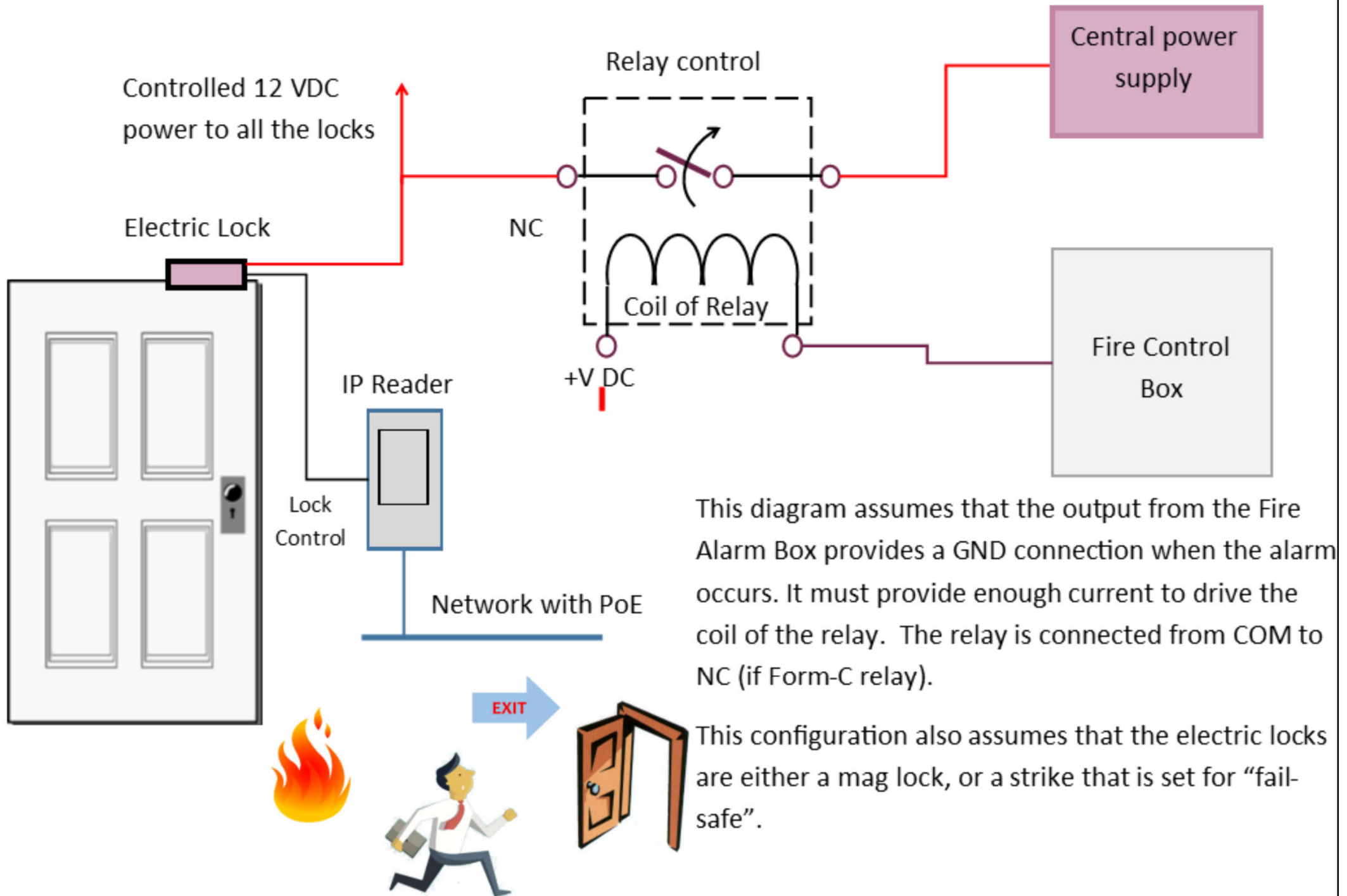
(a) With basic (non-intelligent) reader

(b) With intelligent reader

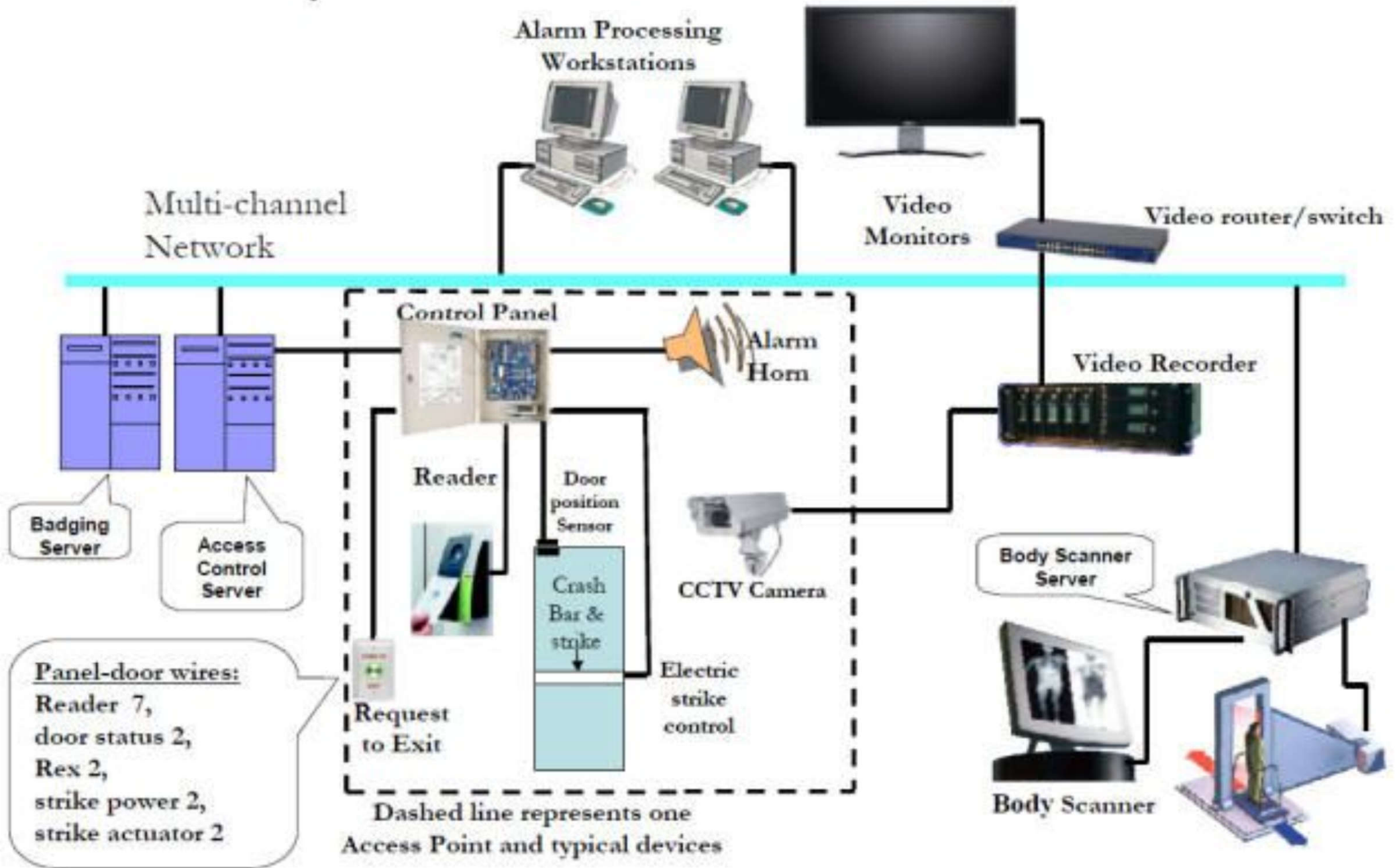
Access control system using IP controllers



How to integrate access control with fire alarm systems



Architecture of an access control system with network support



Access control systems



- Intercom systems

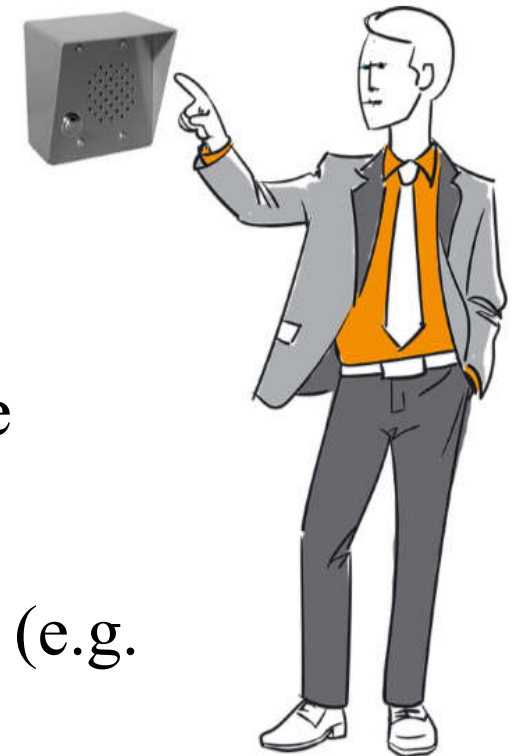
- Audio intercoms

- One to one connections (two-way audio)
- Many intercoms to a central control centre

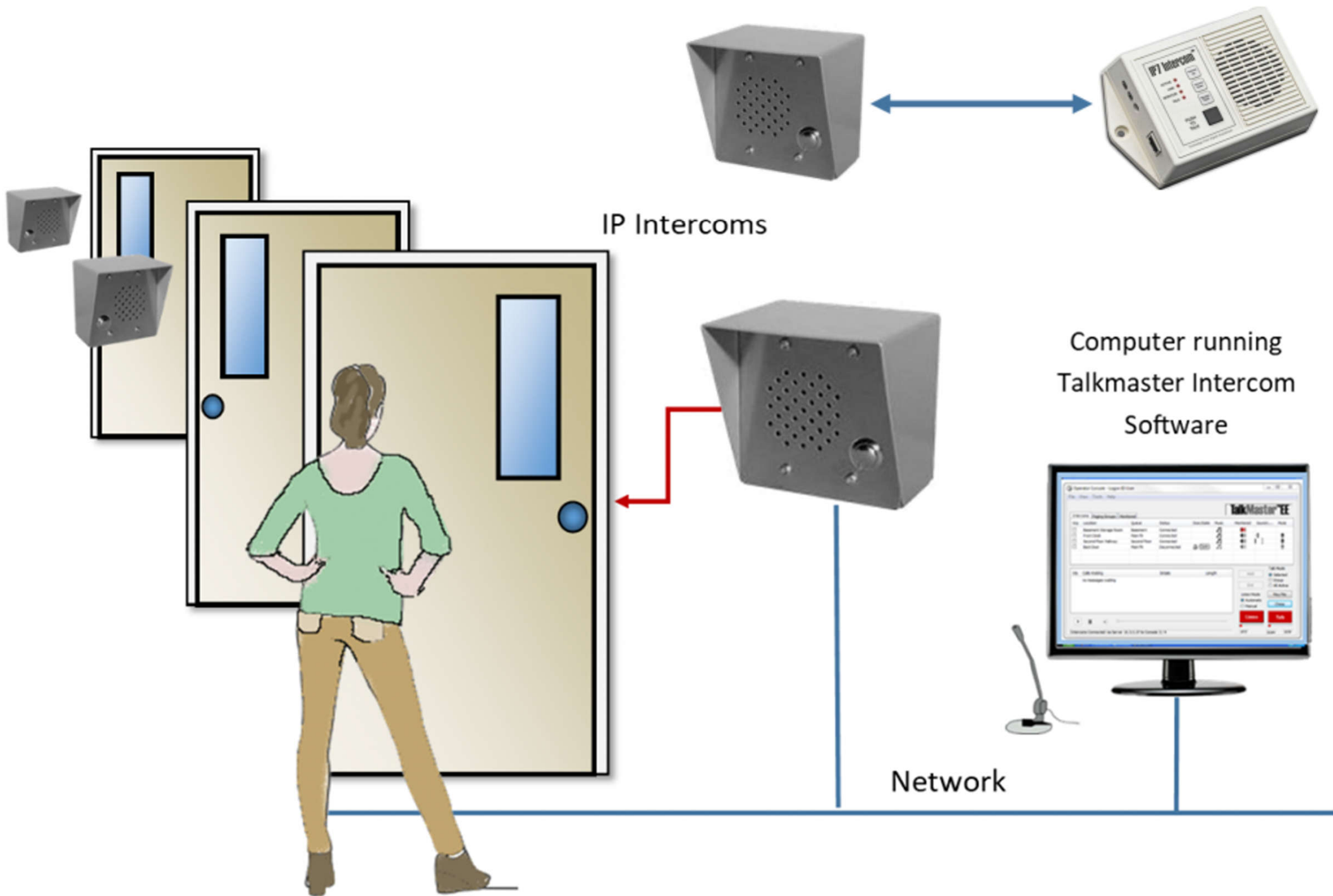
- Video intercoms

- One intercom to one or many connections (e.g. smartphones & a central computer)
- Integrate with IP camera systems & door access control systems to provide a complete security system

- Visitor control systems (e.g. a delivery person)



Audio intercoms for door access control

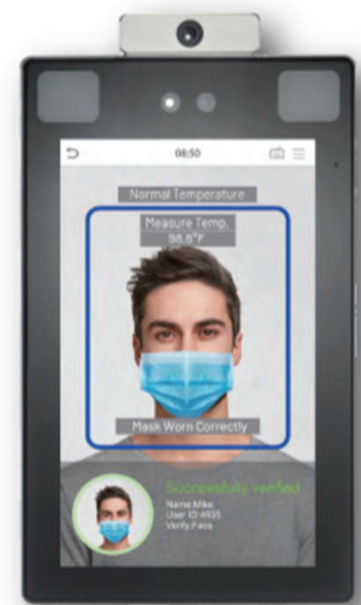
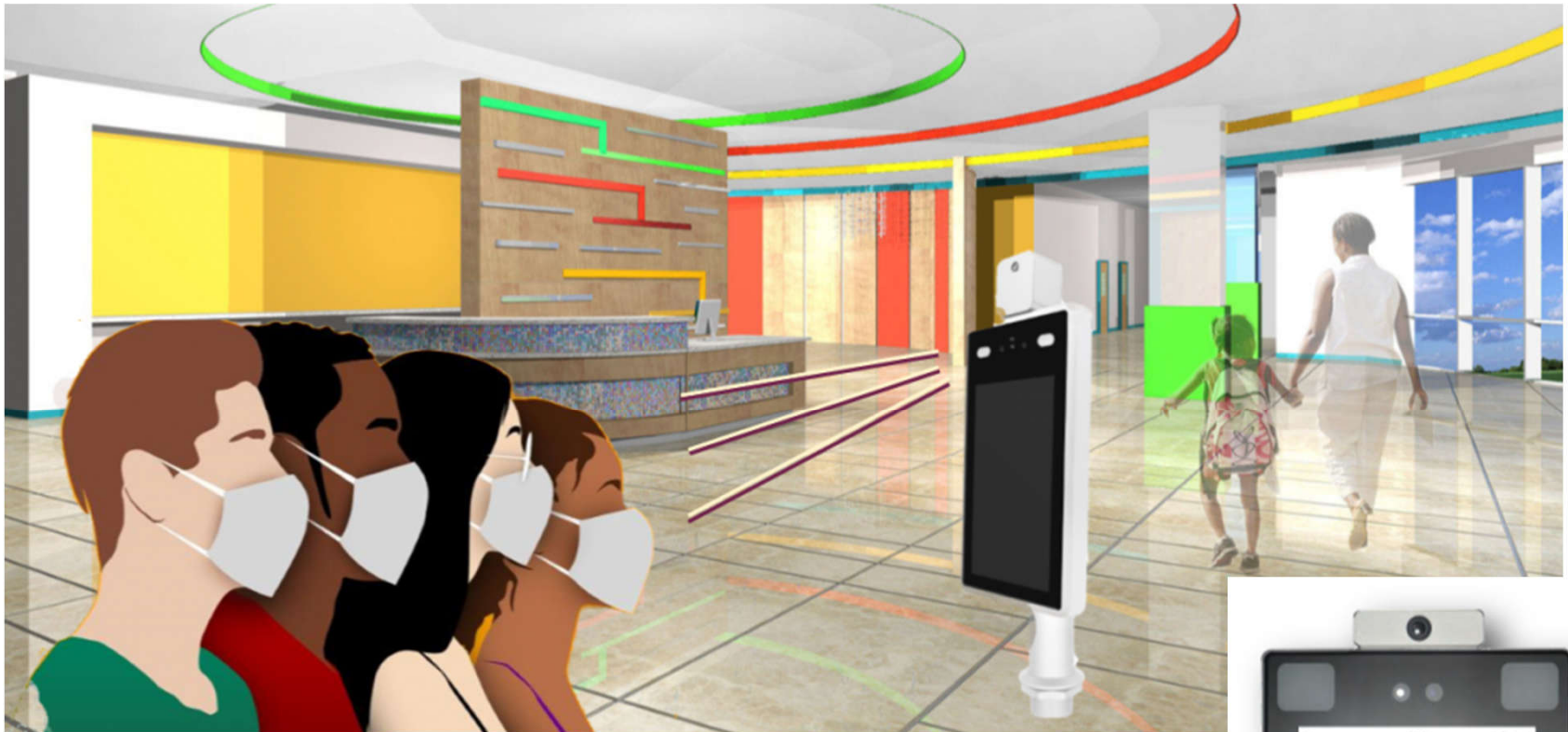


Video intercoms and smartphone communication



(Source: <https://kintronics.com/ip-intercom-selection-and-comparison/>)

Biometric and body temperature access control (check a person's temperature and check if they are wearing a mask)



Video: Access Control with Temperature Monitoring (1:44) <https://youtu.be/w49T2gpbz8Q>

(Source: <https://kintronics.com/solutions/ip-door-access-control/comparison-of-face-recognition-and-temperature-access-control-panels/>)

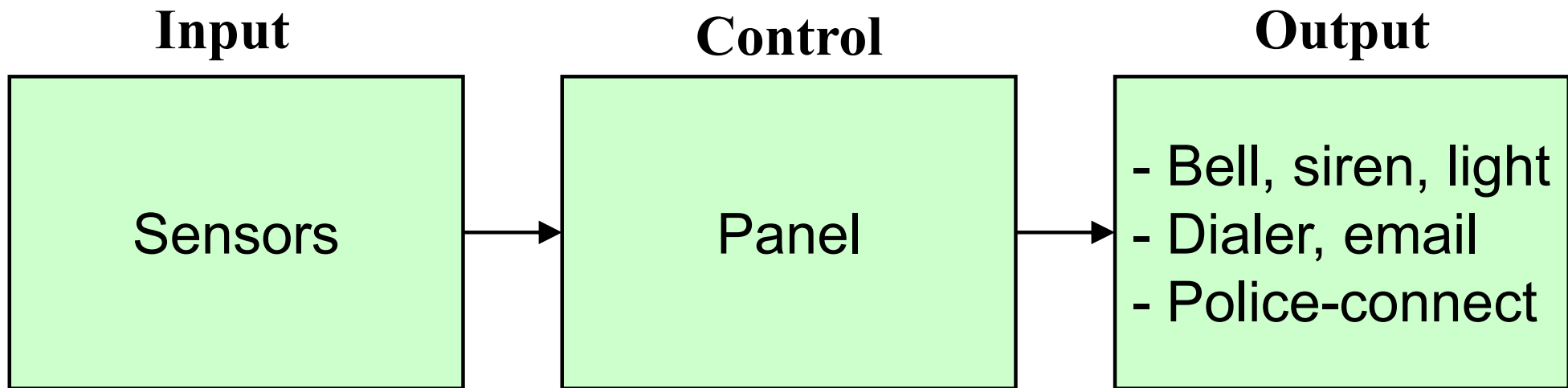
Burglar & intruder alarms



- Burglar alarm system include:
 - Control panel
 - Keypads
 - Intruder detectors and motion detectors (e.g. passive infrared, microwave, or photoelectric)
 - Door & window magnetic contacts
 - Alarm bells or siren
 - Central monitoring station/company (optional)



Basic approach of an alarm system



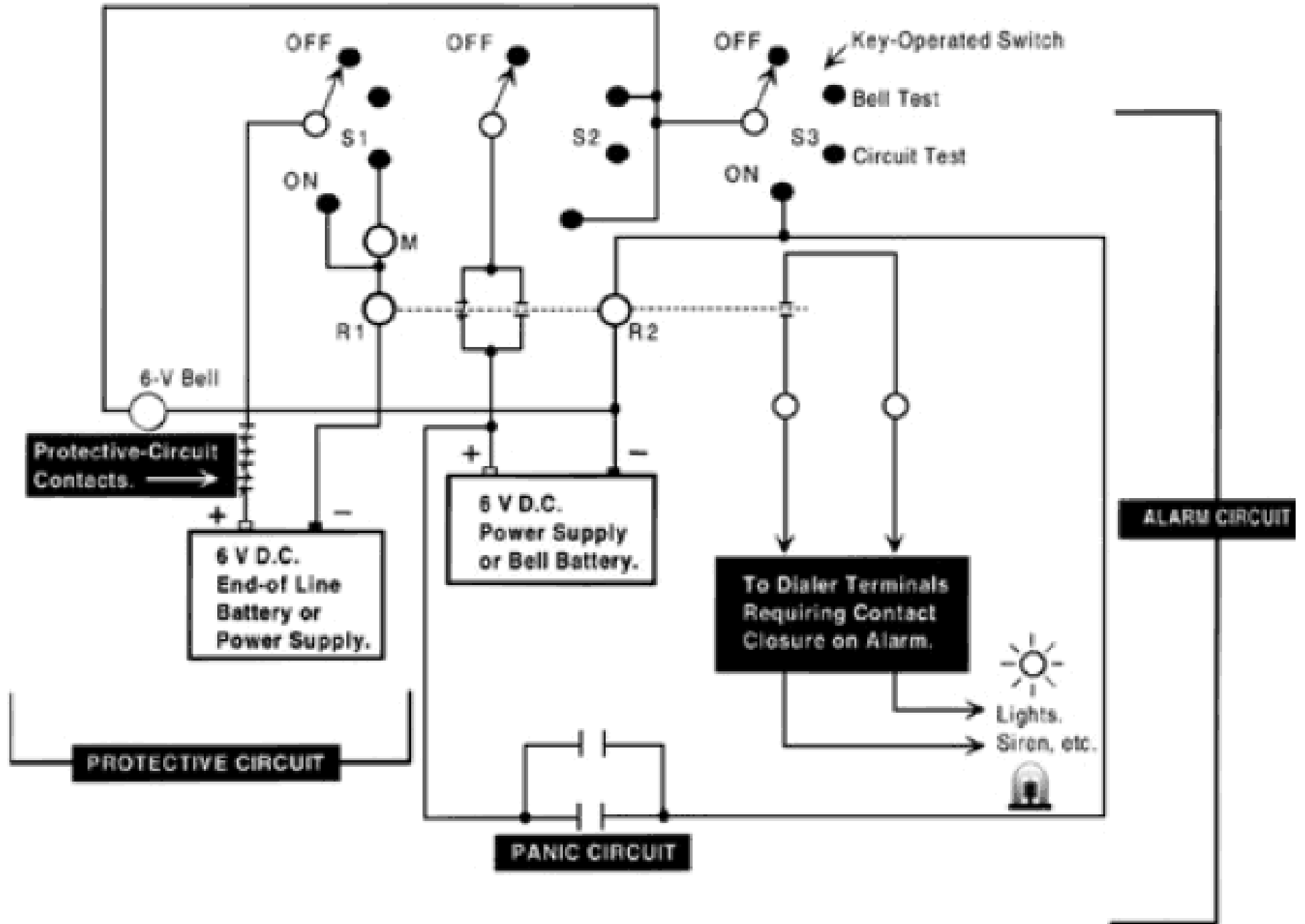
Detection sensors:

- Infrared
- Ultrasonic
- Microwave (Doppler effect)
- Dual technology
- Glass breaks, switches

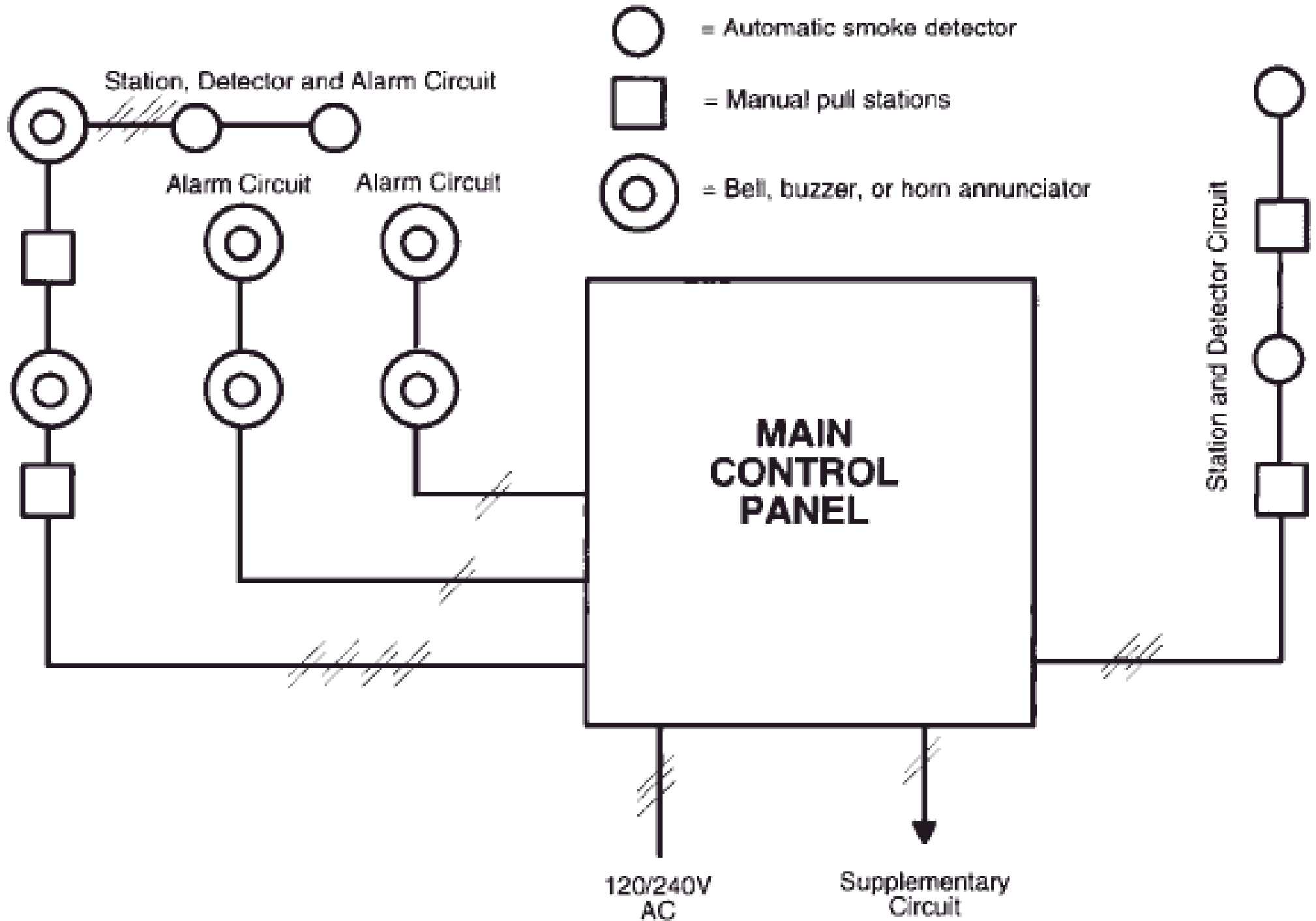
Annunciation/ alarm signaling



Closed-circuit security alarm system

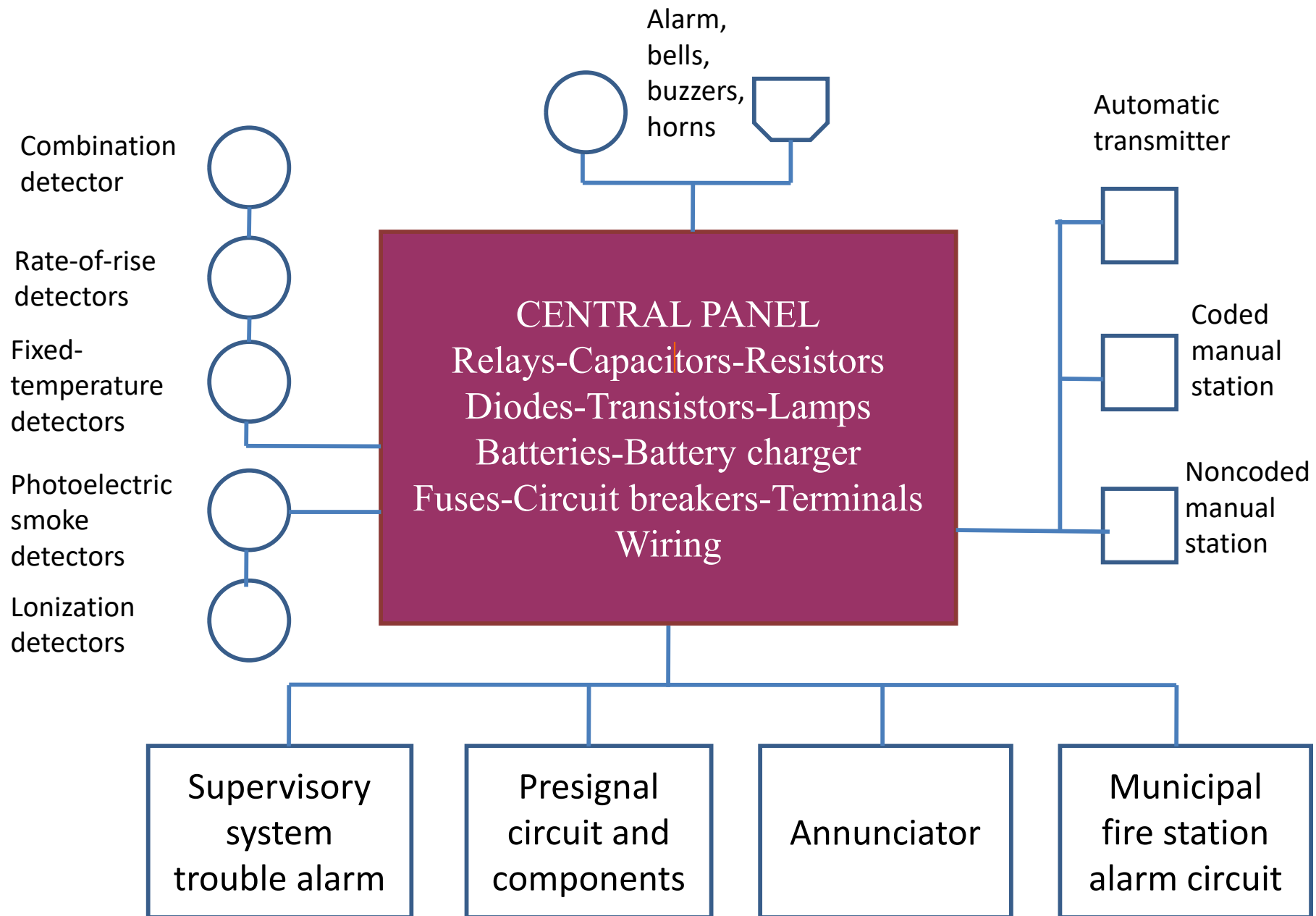


Schematic diagram of a fire-alarm main control panel



(Source: Kennedy, T. and Traister, J. E., 2002. *Low Voltage Wiring: Security/fire Alarm Systems*)

Components of a basic fire-alarm system

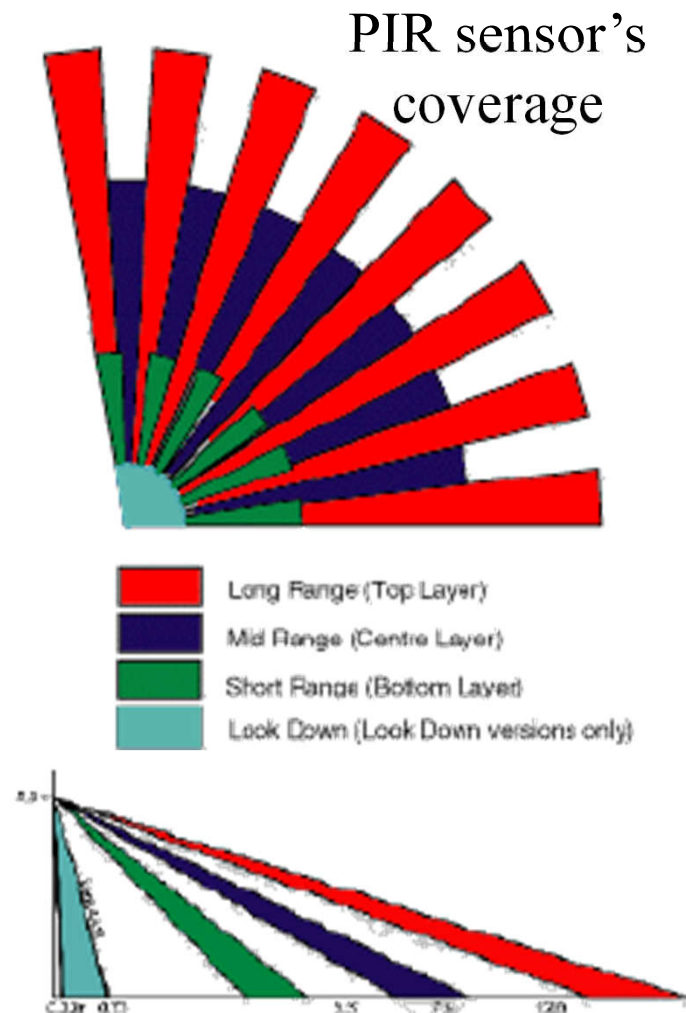




Burglar & intruder alarms

- Intruder detection alarm system

- Mechanical contact switch
- Magnetic contact switch
- Glass-break & vibration detector
- Photo-electric sensors
- Motion sensors
 - e.g. passive infrared (PIR) sensors
- Signaling devices
 - Both audible and visual types



Example of an intruder detection alarm system



Components of intrusion detection alarm systems



- smoke detectors that detects smoke and sounds alarm to warn entire family.



-window/door contacts



-motion detectors

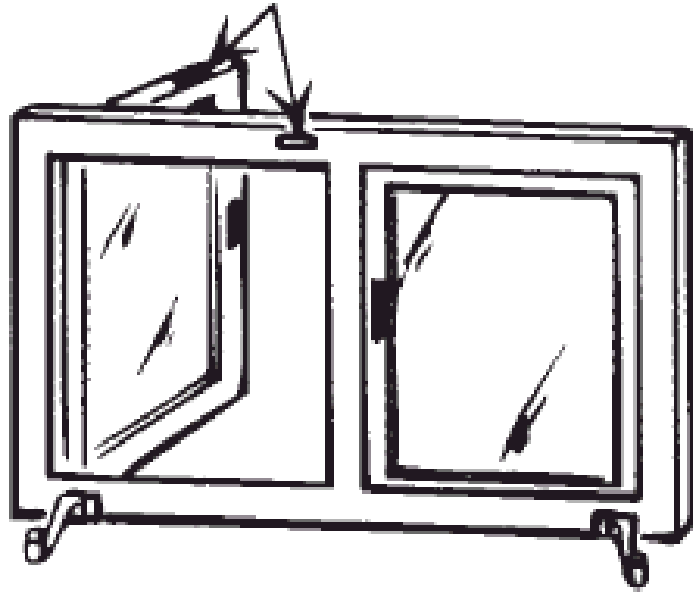


-Interior Siren

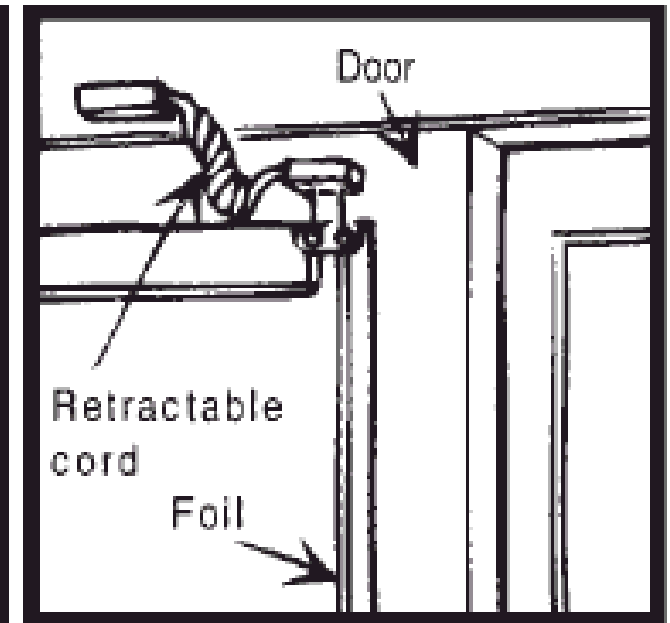
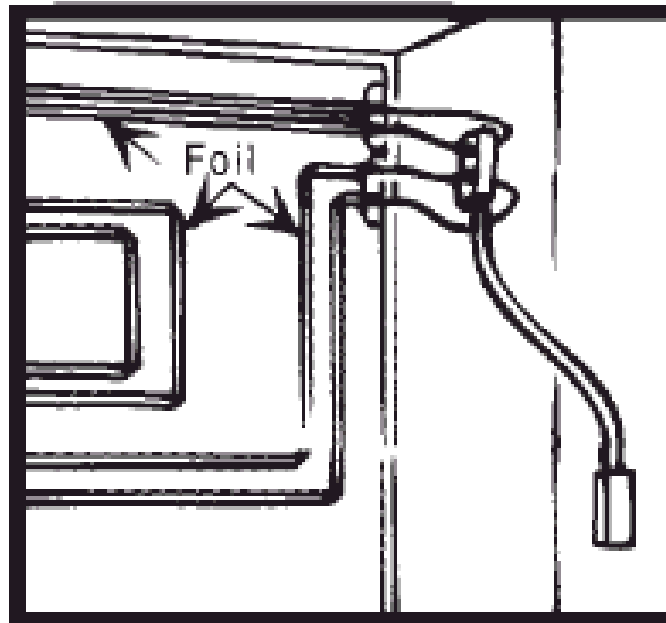
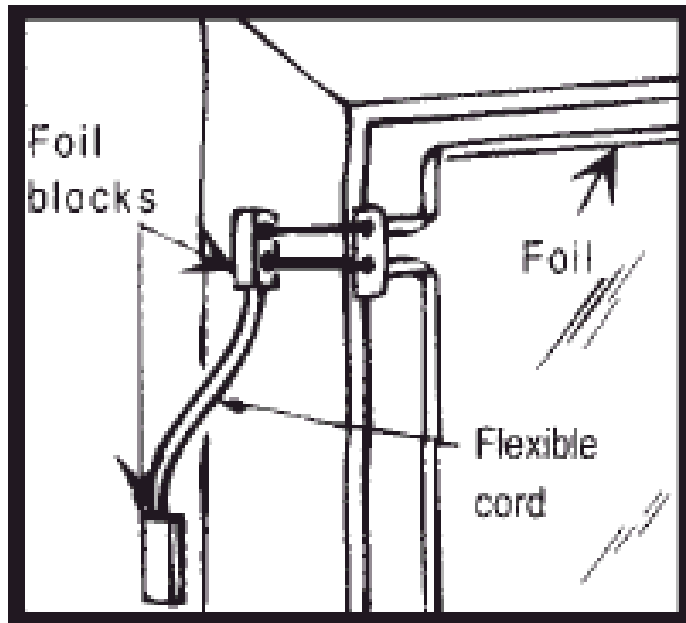
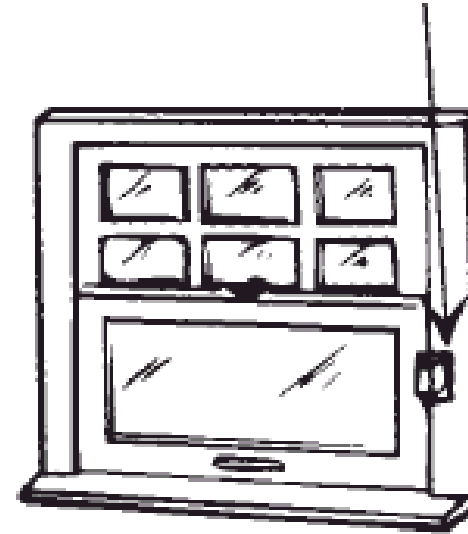


Magnetic contacts on windows and doors

Recessed switch in top casing;
magnet in window top



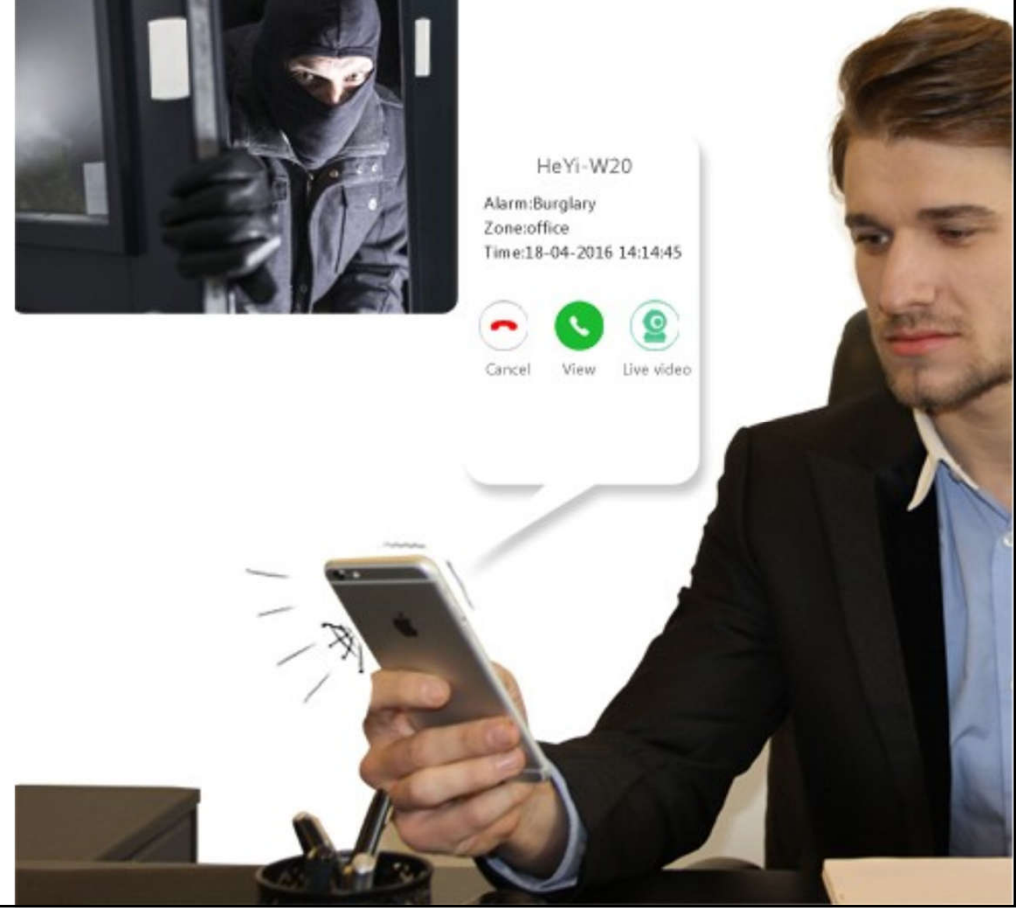
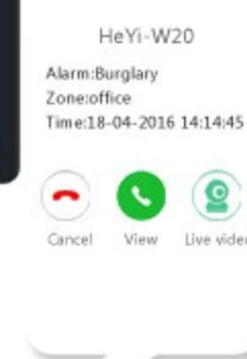
Surface-mounted
switch and magnet



Burglar & intruder alarms



- Additional items to the basic system
 - Smoke detectors
 - Glass break detectors
 - Panic buttons
 - Pressure mats
 - Closed circuit TV
 - Alarm screens
 - SMS alert service !! →



Burglar & intruder alarms



- Monitored systems

- Contact a monitoring company by telephone

- The security system senses something
- The system waits for 30 to 45 seconds before going into alarm allowing the homeowner a chance to deactivate the system to prevent false alarms
- If not deactivated, the security system goes into alarm and sends a message to the monitoring company over telephone lines
- The monitoring company receives the message, determines the nature of the alarm and verifies the alarm, generally by placing a phone call to the home. If they do not receive the proper password or do not receive an answer, they call the police
- The police receive the monitoring company's call and respond



Burglar & intruder alarms



- Unmonitored systems
 - Typically on-site alarms and/or flashing lights to indicate the security system has been breached
 - Relies on neighbours or passersby as to see or hear the alarms and then to call police
 - A combination of strobe lights and alarms
 - Many burglars will leave once alarms and strobes are activated



Burglar & intruder alarms



- False alarms

- 95-99% of the alarms received are false
- Some police departments impose fines for false alarms after a specified number of false alarms



- Common causes of false alarms

- Environmental conditions e.g. a storm that causes loose windows and doors with sensors to rattle
- Wandering pets that are not in a "safe" zone and may activate motion sensors
- Drafts that move objects such as curtains or plants in the home within the motion sensor's detection area

False alarm management scheme in Hong Kong

防盜警鐘分級處理計劃

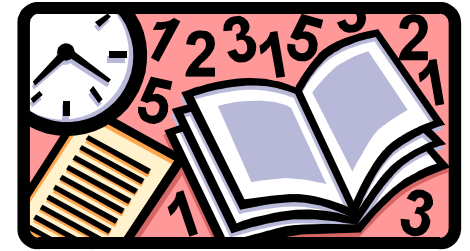
Do you know
how to overcome
false alarm
problems?

- 第一級 - 新警鐘/可靠性系統 new alarm/reliable system
Level 1
(衝鋒隊及巡邏人員 - 留守一小時)
(Emergency Unit & Patrol – stay 1 hour)
- 第二級 - 30天內 3次誤鳴、180天內 5次誤鳴
Level 2
3 false alarms in 30 days; 5 in 180 days
(巡邏人員 - 不需留守)
(Emergency Unit & Patrol – no stay)
- 第三級 - 30天內 5次誤鳴、180天內10次誤鳴
Level 3
5 false alarms in 30 days; 10 in 180 days
(通知巡邏人員 - 不需優先處理)
(Patrol – no priority to take care)



Further Reading

- Extra-low voltage - Wikipedia https://en.wikipedia.org/wiki/Extra-low_voltage
- Security Products
https://www.police.gov.hk/ppp_en/04_crime_matters/cpa/sec_products.html
- CCTV - Designing Buildings Wiki
<https://www.designingbuildings.co.uk/wiki/CCTV>
- Introduction to Access Control Systems
<https://www.silvaconsultants.com/intro-to-access-control-systems>
- Introduction to Intrusion Alarm Systems
<https://www.silvaconsultants.com/intro-to-intrusion-alarm-systems>
- Basic information on intruder alarm systems
https://www.dipolnet.com/basic_information_on_intruder_alarm_systems_bib770.htm



References

- CA, 2012. *Code of Practice for the Installation and Maintenance of In-Building Telecommunications Systems and In-building Access by Telecommunications Network Operators*, Communications Authority (CA), Hong Kong.
<https://www.coms-auth.hk/filemanager/statement/en/upload/105/cop201202e.pdf>
- Kennedy T. & Traister J. E., 2002. *Low Voltage Wiring: Security/Fire Alarm Systems*, 3rd ed., McGraw-Hill, New York.
- HK Police requirements for digital CCTV systems
<http://www.police.gov.hk/info/doc/cpa/CCTV%20English.pdf>